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McGRAW-HILL WEEKLY FOR DESIGN ENGINEERS · MAY 22, 1961

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see page 3

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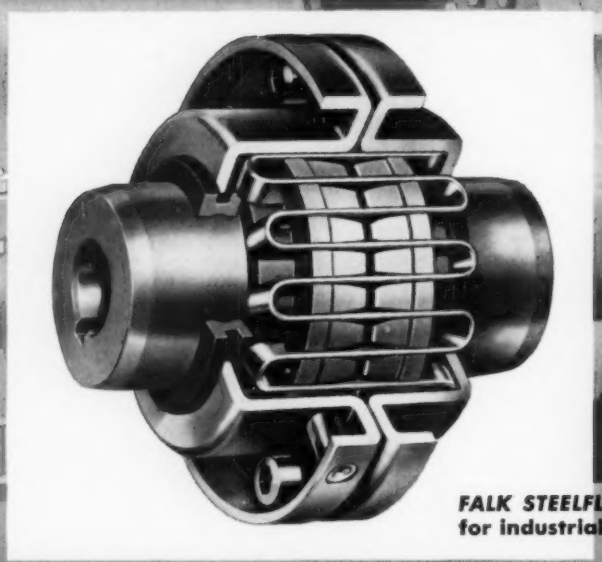

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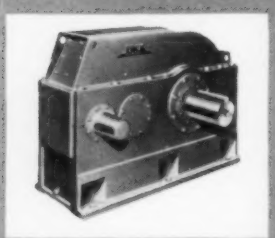

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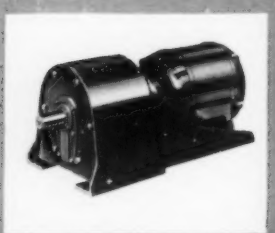

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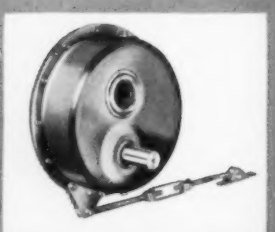

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McGRAW-HILL WEEKLY FOR DESIGN ENGINEERS

May 22, 1961 Vol. 32, No. 21

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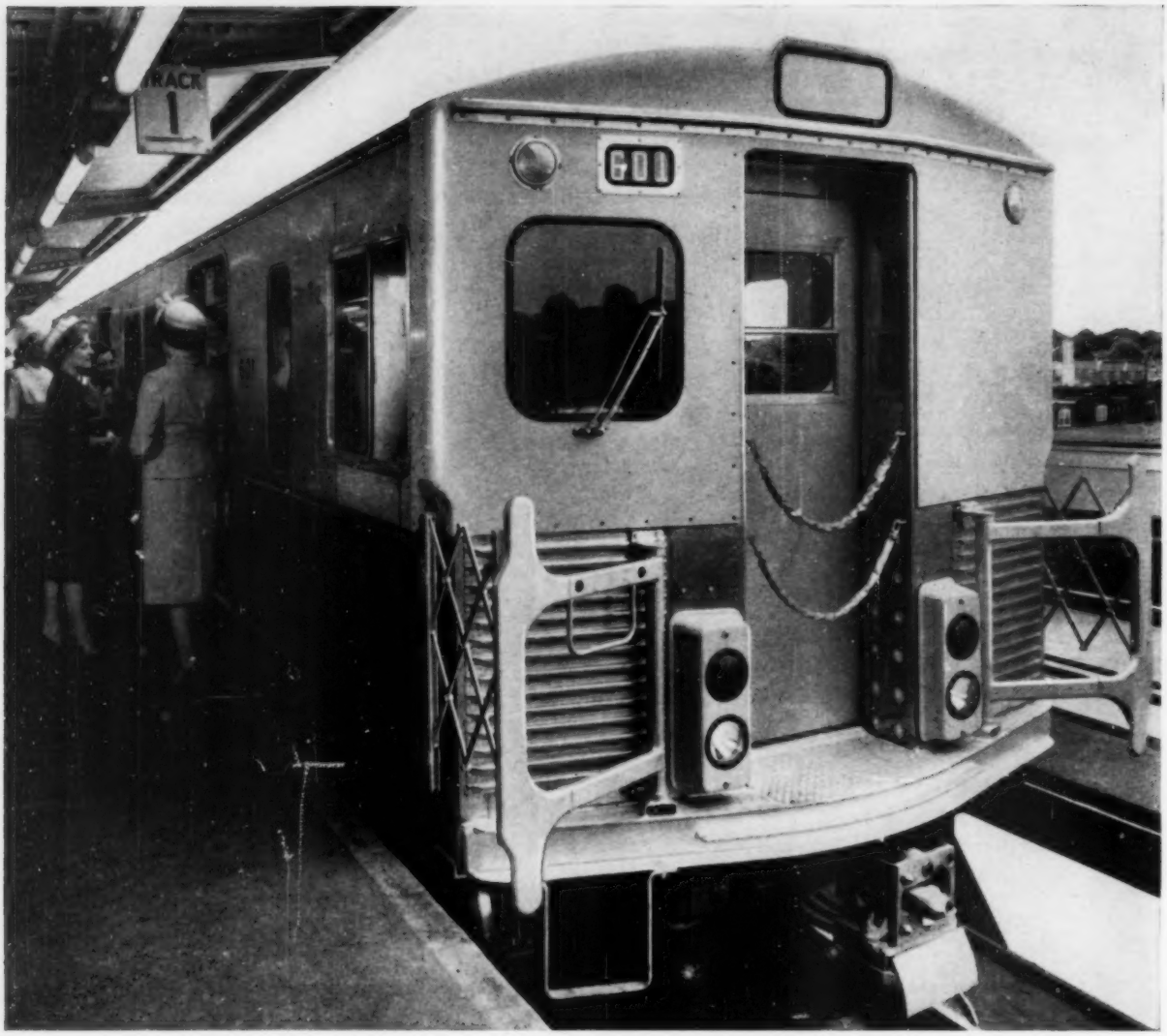

How Nickel Stainless Steel "lightweights" curb Philadelphia subway costs by $6.4 million

Commuters using the Market-Frankford elevated subway line in Philadelphia are smiling these days. So are transit authorities. That's because the line's new subway cars are the most modern in design for passenger comfort . . . and the most economical the city could buy.

Compared to competitive subway cars, during a 35-year depreciation period these new Nickel Stainless Steel cars will:

Operate on $2.4 million less power. They are solidly constructed, yet are so light they run on 12% less electric power than conventional cars based on the same specifications but fabricated from other materials.

Require $4 million less maintenance. Designed and built from Nickel Stainless Steel by The Budd Company to specifications set by the City of Philadelphia and the Philadelphia Transportation Company, these cars need no painting and virtually no exterior maintenance . . . because Nickel Stainless Steel resists corrosion and retains its handsome finish.

And because they are the lightest cars for their size ever built, they:

Help cut running time by 6 minutes. Thanks to the excellent combination of stiffness and high strength found in Nickel Stainless Steel, their thinner-gauge body shells reduce costly deadweight and make it easier for powerful motors to increase acceleration and braking rates.

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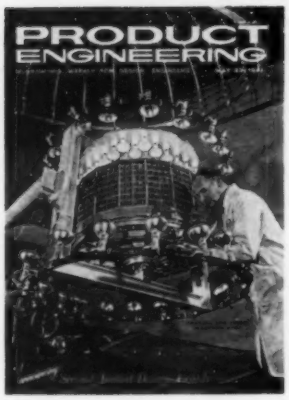
INTERESTING TO NOTE



On our cover–Tiros II, launched into orbit last November, has proved to be one of our most successful satellites. The 280-lb drum-shape device contains television cameras, TV tape recorders, infrared sensors, and other such equipment–all designed to conform to a strict weight schedule.

Any piece of equipment for space presents problems not usually encountered. According to Sidney Sternberg, chief engineer, RCA Astro-Electronics Div, "You know that every piece in the system will encounter more stress and shock in a few minutes of launching than most ground systems face during years of operation. When you mount the package on the rocket and seal it up, you've had your very last look at it. If any one of the 20,000 or more parts (even a conventional transistor) gives out, no service man is going to be around to slip in a replacement. Every big electronic system calls for a heavy dose of imagination, perspiration and faith, along with good solid engineering."

Tiros II was no exception. One particular problem concerned the dynamic aspects of keeping the satellite stabilized in orbit. Prior to its separation from the third-stage rocket, the satellite would be spinning at about 120 rpm to keep it and its carrier on even keel. There was a chance that in the separation process Tiros might acquire a side-to-side wobble. So the engineers fed computers, built special test equipment, designed a system of sliding weights inside the satellite to absorb the wobble, and added "yo-yo" weights (*PE*—Apr 3, p 56) at the end of long cables to slow the spin rate to between 10 and 12 rpm–the slow rate needed to maintain stability without hindering picture taking. Edwin A. Goldberg, who shared with Vernon D. Landon the engineering management of the Tiros project for RCA, remembers that "you had to be careful about sticking your head into rooms around here. There were some spots where you stood a good chance of being flailed by flying weights. You can still see some dents in the walls."

The satellite had to undergo additional torture tests. For example, NASA requested that it be subjected to a force of 30 g's. RCA engineers found a centrifuge large enough to hold Tiros, but when the machine was revved up to 30 g's a near tragedy occurred. A weight on the centrifuge broke loose and crashed into the satellite. It took three days of around-the-clock surgery to repair the damage, by which time NASA decided the satellite would have an easier time surviving in space than in the test lab.

You Can't Patent These

Several weeks ago, in Detroit, a panel of judges decided on awards for 9 of the 91 entries in this year's Master-Design competition, originated and sponsored by PRODUCT

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ENGINEERING. The winning entries are described on page 35.

But the nation's largest award granter remains the US Patent Office. Though some of the recipients of patents might not win prizes, they do show imagination. Take the combination nightstick, flashlight and alarm invented in 1957. It's supposed to be carried by anyone afraid of nocturnal ambush—if it's dropped or happens to come into contact with an attacker, an alarm goes off. But this is child's play compared with the combination flashlight, gun and billy. Not only can you crack somebody's skull with this, but you can blind him with tear gas or shoot him with a concealed gun. It was invented in 1944 by two Californians for policemen, guards and soldiers.

Many of the offbeat inventions relate to easing the burdens and discomforts of life. For example, in 1898 a patent was granted on an electrical bedbug - exterminator. Said the inventor, "It consists of electrical devices applied to bedsteads in such a manner that currents of electricity will be sent through the bodies of the bugs, which will either kill them or startle them, so they will leave the bed." Another startling device is a music box that can be inserted into a woman's high-heeled shoe.

An 1896 patent—just press a button and the hat is automatically tipped to a lady.

Sportsmen also have received patents on ideas—to enhance their pleasures. A fisherman from West Virginia devised a fishing rod with a portable radio in the handle and the antenna in the rod. And in 1947, application was made to patent a condiment-holder—a flashlight that could dispense salt and pepper. The inventor observed "sportsmen normally having flashlights in their possession often find themselves in need of seasoning for foods."

—Benedict A Leerburger Jr

SIDELIGHT

A dummy with a flat head, fleshless plywood bones and a trick spine is teaching employes how to avoid back injuries at Dayco Corp plants. The device works on a simple leverage principle. There are movable joints at the ankles, knees, hips and shoulders. The backbone is a series of wooden blocks held together by elastic strips. The student provides the lifting power at a handle at the base of the dummy's spine.

With the load properly placed, the dummy's knees are bent and the back is straight—almost vertical. When pressure is applied to lift the load, maximum strain is placed upon the dummy's legs instead of the back and he reaches a standing position without mishap. But when the load is too far forward, the dummy's back is forced to bend, putting it under a strain. When you try to get the dummy to lift the load in this position the extra stress causes the backbone sections to separate with an alarming snap.

"Very instructional," says Dayco's safety director.

NEXT WEEK IN PRODUCT ENGINEERING

. . . **Fast-response Temperature Controls**
When temperatures are measured under cooling or heating conditions, time lag of the sensing element may introduce substantial errors.

. . . **Calculation Forms Can Speed Design**
Make up a form in advance and repetitive calculations become simply a matter of filling in the blanks.

. . . **Should You Make That Speech?**
How do you evaluate the speech invitation, for yourself, for your company, for the profession?

. . . **Snap-in Access Panels Preserve Clean Look**
These doors show no hinges or handles, need only finger holes or prying lips for positioning.

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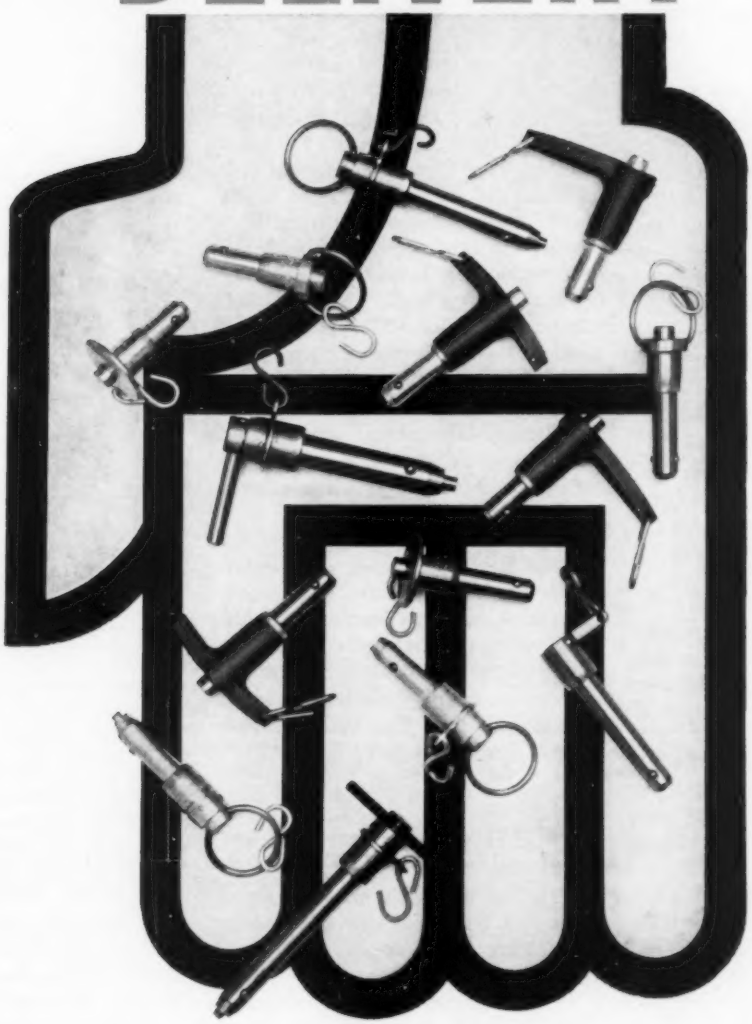

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WHAT'S HAPPENING IN RESEARCH...

Adding strength to the high-strength steels

The high-strength, oxidation-resistant iron-manganese-aluminum alloys can be given a stress-rupture life better than that of AISI type 316, Defense Metals Information Center says. The method: addition of either tungsten or molybdenum in amounts of 1% or more to the basic composition: Fe—35 Mn—8 Al—3 Ni—0.5 V—0.6 C.

A preliminary report on work in progress at Crucible Steel under Dept of Defense sponsorship indicates that stress-rupture life can be increased by a factor as great as 10—from 5 hr to 50 hr. The finding is particularly important because, as the formula indicates, this alloy achieves its oxidation resistance without the aid of chromium, and with only a minimum nickel content.

Recent attempts to improve the mechanical properties of other high-strength stainless alloys have not been as successful. Tensile strengths as high as 280,000 psi have been achieved with commercial alloys, but ductility is very low. Says DMIC: application of these alloys apparently will depend on ability to design with a brittle material.

New coats for Inconel control heat dissipation

Ceramic coatings that can provide high emissivity at high temperatures and high reflectivity at the same time are being developed at Arthur D Little Inc.

In a report prepared for the American Ceramic Society, D. G. Burgess of ADL says two types have been made, both using a barium silicate base:

Coatings with total normal emittances ranging from 0.74 to 0.87, serviceable at temperatures to 2200 F, were made by incorporating black spinels in the barium silicate frit.

With the aid of stannic and ceric oxide opacifiers, enamels with hemispherical reflectance of 0.67 and 0.62 at wavelengths of 0.6 to 2.6 microns were produced. These have total emittances in the 0.75-range at 750 F, and 0.60 at 1400 F, when applied to Inconel in thicknesses of 5 mils or more.

Work is continuing to optimize both properties.

Heading for better piezoelectrics

Improved piezoelectric materials for transducers are promised by research now underway at GE (Syracuse) and Bell Labs. Both groups are studying niobate (columbium) systems—GE is working on lead metaniobates and Bell Labs on potassium-sodium niobates.

Reporting at the American Ceramic Society annual meeting, the GE Electronics Lab researchers noted that ferroelectric lead metaniobate has a high curie (magnetic transition) point, but a relatively low piezoelectric response. However, substitution of akaline earth oxides (barium oxide, for instance) for all or part of the lead oxide can bring substantial improvements in both electrical and mechanical properties.

The Bell Labs group is emphasizing fabrication techniques as a route to improvement of the potassium-sodium niobates. Hot pressing, BTL says, yields ceramics with relative densities greater than 99%, and piezoelectric properties are significantly enhanced. Dielectric constants increase, too; but ac losses remain relatively high. The materials will, Bell Labs believes, be especially useful in electromechanical transducers for the 10-20 mc/sec range.

First reports on fuel oil studies

The oil industry's major effort to boost oil heat efficiency and broaden its market (*PE—Jan* 16, p. 9) is already beginning to bear fruit.

The American Petroleum Institute's Marketing Div-reports two interesting developments:

- A theoretical model of fuel droplet combustion, which permits calculations of flame velocity and distance required for complete combustion of fuel droplets, has been created by R. E. Paterson of California Research Corp and D. F. Fairbanks of Chemical Engineering, at MIT.
- A shortcut method of determining atomizer-drop size is reported by J. R. English of Esso Research and Engineering Company. With an immersion sampling technique, he says, only a few of the larger particles in a sample need be measured. The mass median diameter is then estimated from these particles, using an empirical correlation. The standard deviation is about plus or minus 9%.

Now underway, at independent research organizations, are studies of new atomization and ignition techniques and air-fuel mixing and recirculation. Reports are expected within the year.

Test liquids may cause delayed strength loss

The inks and fluids used for hydrostatic and fluorescent inspection can slash stress-fracture strength as much as 40%, Naval Research Lab reports. It's a delayed-action effect that may not show up for several hours or days after testing.

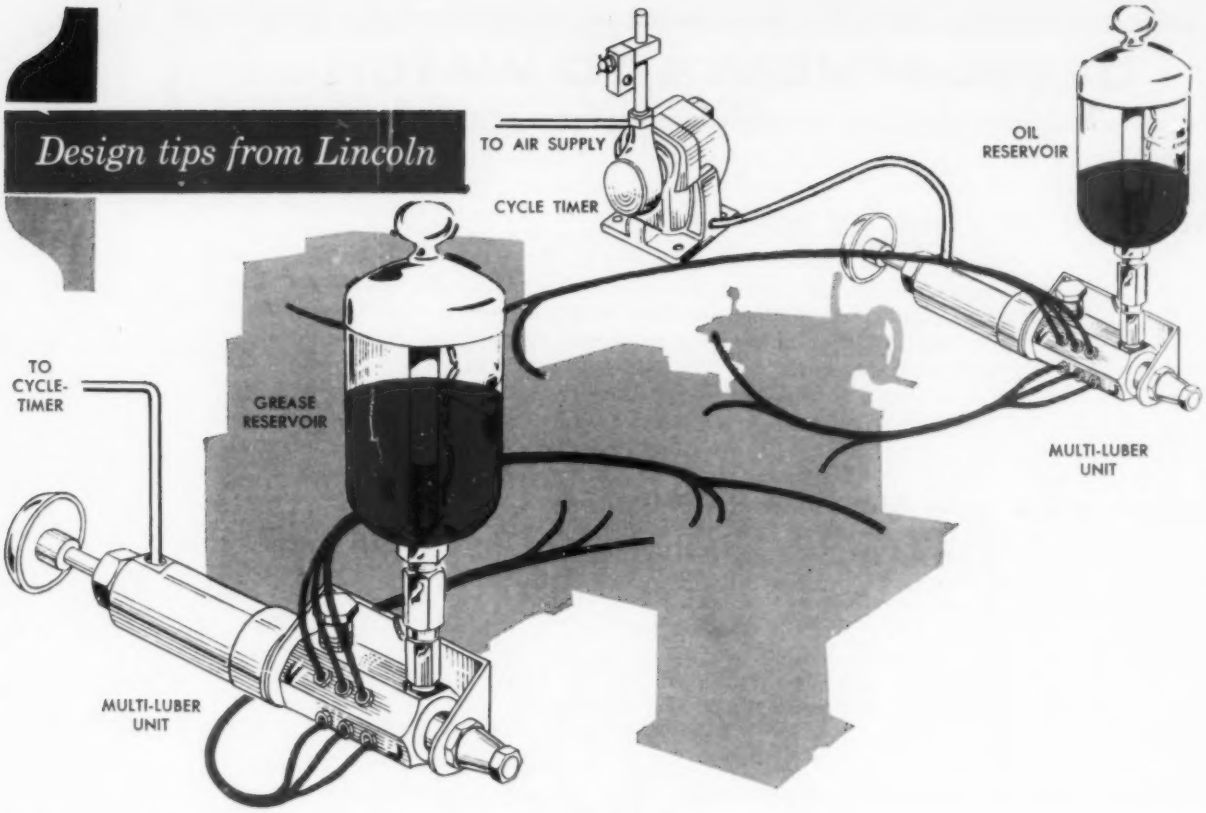
High-strength steels of the type used for rocket chambers and pressure vessels (X200, M255, 300M) exposed to tap water, distilled water and fluorescent inspection liquids, show a marked drop in gross fracture strength. X200 seems to be most seriously affected; M255, least.

Even the ink used to mark the steel after testing may have a deleterious effect. Specimens exposed to India ink showed the greatest loss of strength.

A good deal of protection may be obtained, H. L. Smith, W. E. Anderson, and K. McKinney of NRL report, through application of protective oils and chemicals prior to exposure to the liquids; but not all such compounds are equally effective.

Work is continuing to find out why the failure occurs (stress corrosion? hydrogen embrittlement? liquid absorption?) and what the protective mechanism is. —ARG

Design tips from Lincoln



Supply Grease and Oil with Separate Multi-Luber® Systems

You can use Lincoln's versatile Multi-Luber to provide automatic lubrication for all types of bearings on light machinery. The illustration above shows how two Multi-Luber units can be used on a machine lathe: one unit to supply special light oil for super finish spindle bearings . . . the other unit to supply grease to the rest of the bearings.

You can use compressed air, electricity or machine motion to cycle the Multi-Luber automatically and you can choose the lubrication timing cycle you want for each unit. The unit can also be cycled manually by pushing the plunger handle. This feature is important when light oils are used that may drain from the bearing housing. Some plants cycle the Multi-Luber manually before starting up any unit, some only after prolonged shut-down.

With standard setting, the Multi-Luber discharges 0.0025 ounces of lubricant from each of the 12 outlet ports every time it cycles. The simple Multi-Luber design and its positive displacement method of lubrication give you the most reliable system for lubricating light machines.

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DEVELOPMENTS TO WATCH...

Transparent nylon ready for work

Nylon with a transparency close to that of glass (refractive index: 1.53) has been developed by DuPont, and is now being evaluated for such applications as business-machine part covers and food and dairy equipment shields and windows. Best adapted to extrusion and blow molding, the transparent nylon (to be known as FE 2345) has a slightly higher viscosity range than most general-purpose nylons, but resembles them in other respects. Melting point is approximately 400 F and specific gravity is about 1.1. DuPont says it can be made available in quantity at economic cost.

Another plastic gains heat resistance and clarity

Significant improvements in heat resistance and stability of polyvinyl chloride and other vinyl halide resins is promised by Swift & Co as its new PVC plasticizer and stabilizer goes into full commercial production. It represents the latest advance in a series of epoxidized oils, developed specifically for use as stabilizing plasticizers. Extrusions containing as much as 50% of the new epoxy compounds (Swift calls them Epoxols) show excellent clarity and flexibility. The stabilizers are being evaluated by formulators and should soon be in commercial use.

Titanium reduces graphite permeability

To develop a graphite with improved erosion and oxidation resistance and decreased permeability, Britain's Hawker Siddeley Nuclear Power Co is testing a variety of impregnants. A good deal of success has already been achieved with organics such as furfural alcohol. Density has been increased from 1.7 to 1.8 g/cc and porosity reduced from 15 to 4%. Now, such novel impregnants as titanium, silicon, boron and boron compounds are being investigated.

Preliminary reports indicate that titanium vapor, diffused into the graphite by pressure-gradient techniques, can also bring porosity down to as little as 4%, while increasing density at least 5%.

Research is continuing, and the US Army, which is sponsoring some of the work, sees good reason to believe that further improvement in diffusion methods will bring even better results.

(Note: For more on improved types of graphite, see PE—Apr 24, p 8 and May 1, p 8)

Electropneumatic control features solid-state devices

A semiconductor temperature controller that provides for multichannel sensing has been developed by Powers Regulator Co. It features a tri-stable electropneumatic relay that converts electrical inputs to a pneumatic output.

A thermistor in a bridge circuit serves as the temperature-sensing device in the Powers unit, and the output differential current of a magnetic amplifier drives its transducer. The transducer itself is an air-valve mechanism operated by a differentially wound electromagnet.

Feedback is provided by an E-I type differential transformer whose movable armature is positioned by an adjusting spring and bellows. An excitation voltage is applied to the primary of the transformer; and the output signal from the secondary, which is proportional to the armature position, is demodulated and fed back through a sensitivity control network to an output winding of the magnetic amplifier. This closes the "proportionality loop."

At the Phoenix IRE symposium on Process Control Instrumentation, Leslie R. Axelrod of Powers pointed out that as many as 3 bridge circuits can be used in a system of this type, permitting its application to 3-channel averaging operations and other relatively complex controls.

Ceramics boost heat resistance of capacitors

A ceramic that paves the way for higher temperature capacitors is reported by GE's Electronics Lab. It's aiming for a material serviceable at 530 F and above, with a dielectric constant of 50 or more, an electrical volume resistivity that exceeds 10^{7} ohm-cm, and an RC product of at least 5 sec. Most promising so far: a strontium tantalum zirconate. It may not be the final answer, but A. V. Illgn and E. C. Henry of GE say it exceeds the requirements in 60 volt/mil life tests at temperatures to 660 F; and they believe it represents an approach permitting further improvements in electrical resistivity of dielectric ceramics.

Two new magnetic tapes developed in West Germany

A self-adhering magnetic tape and a magnetic laminating tape that is readily heat-sealed in place have been developed by Agfa of Leverkusen, Bayerwerk, West Ger.

They can be used to apply magnetic coatings to cards and checks for magnetic selection and recording; to paper and plastic sheeting for magnetically controlled cutting; and to sheets, disks, and cylinders to permit their use as computer storage devices.

Neither material is yet available in the US, but licensing agreements are to be made.

The self-adhering tape has a 0.5-mil magnetic coating and a ½-mil prestretched polyester film base. The laminating tape uses a thinner base, because the coating strips off, adhering unsupported to the item to which it is applied, and is provided with a heat-sealing adhesive. Application temperature is about 230 F.

Low-voltage electrical indicator features novel design

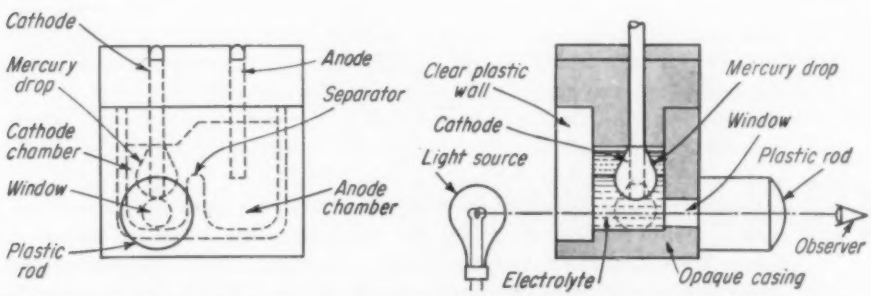
An indicator-light system that's built like an electrolytic cell and operates by means of surface tension has been designed by IBM engineers. It does just what a neon bulb can do, they say—but operates at low voltage (1 to 3 v) rather than at line potential as neon bulbs do.

The design takes advantage of the fact that the surface forces which act on and control the shape of a drop of liquid are electrical in nature. Subjecting the drop to an electrical potential can, therefore, increase or decrease its surface tension.

The cell is of relatively conventional design, with a central separator dividing it into anode and cathode chambers. A light source is mounted at one side so the light beam follows a predetermined path (diagram). But, in addition to the usual liquid electrolyte, it has a drop of another liquid—mercury, for instance—attracted to the cathode and held in an elevated position by its surface tension.

When an electrical potential is applied across the cell, or when the applied potential changes the surface tension, the drop is unable to maintain its elevated position and falls as indicated by the dotted outline, partially blocking the light beam and reducing its intensity. This change in intensity is a measure of the change in potential. It may be observed visually or monitored by means of a photocell.

Since action of the cell depends on the balance between weight of the mercury and its surface tension, size of the drop must be carefully measured. With an 0.025-in. cathode, 0.052 gm of mercury (drop dia about 0.07 in.) gives good results. Wire length is chosen so its tip just touches the top of the drop when it is resting on the base of the cell. **–ARG**



CHANGE IN POSITION of mercury drop changes intensity of light beam in visual indicator. Cell window and rod are light-transmitting acrylic plastic. Separator keeps mercury from rolling toward anode when cell is not operating.

FROM WASHINGTON...

President seeks bigger budget for manned space flight

A big boost in space spending will be sought by Pres Kennedy in the next week or so. It comes from a major review of the space program by the President's National Aeronautics and Space Council under chairmanship of Vice-Pres Lyndon B. Johnson.

Reports are the President will ask Congress to add up to $600 million for space spending in fiscal 1962. NASA would get bulk of the new money, with an estimated $100 million going to the military. Most of the new money would go to speed up Project Apollo—a three-man vehicle capable of flights to the moon and back. Other programs that will get a boost are solid-fueled rockets, nuclear-powered rockets, and space communication.

Right now, space spending for 1962 is budgeted for around $2.4 billion for civilian and military programs, split about evenly between the two groups.

The next propaganda milestones in space achievements are orbiting a multi-manned vehicle and sending a man to the moon and back. Buoyed by the recent success of astronaut Alan B. Shepard's "Freedom 7" flight, speculation is the US may go all out to try to beat the Soviets to a manned flight to the moon.

All but legal problems are solved for deep diving vessel

Actual construction of the deep diving research vessel Aluminaut is getting close. Major agreements have already been reached by the Navy and Reynolds Metals Company, with final legal arrangements left to be worked out.

Design changes have been agreed on. They include increasing the hull thickness from 6 in. to 6½.; using two propellers instead of one; forging strengthening ribs into the structure rather than inserting them separately; and using a full cylinder concept rather than half-cylinders as originally designed.

Construction of the Aluminaut reportedly will be done by Electric Boat Div of General Dynamics. Actual operation of the vessel for the Navy's Office of Naval Research will be done by Woods Hole Oceanographic Institute.

Industry conflict brews over commercial satellites

Ownership of a commercial satellite communications network is producing a rough-and-tumble fight in industry. The reason is there will be only one such system, but it is expected to become a multibillion-dollar plum.

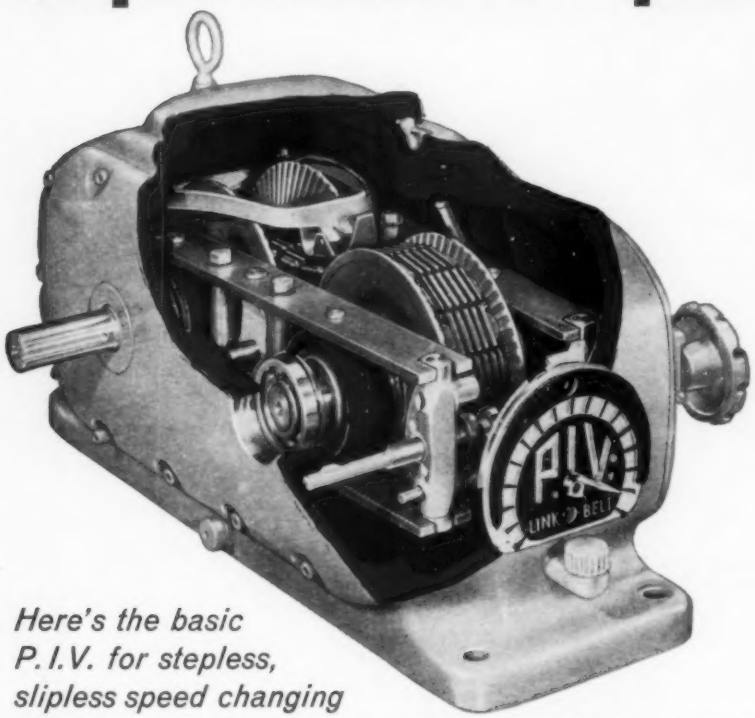
Recently the shape-up in industry over ownership of such a satellite system was brought out into the open by the House Committee on Science and Astronautics.

Power blocs were clearly established when the hearings closed. It is generally accepted that no one company will be allowed to dominate space communications. But, in industry, one bloc wants ownership confined to only international communications companies; another wants domestic communications companies—those now in existence as well as any future ones that may crop up—cut in on ownership; a third bloc wants to draw in the aerospace industry. This would include electronic-component makers and missile and rocket companies such as Lockheed and GE.

Government approval of industry's ownership of a space communication system is still many months away. In the meantime, the National Aeronautics and Space Administration is moving ahead to develop its own communication system under Project Relay. Company proposals for the NASA program were received March 28 and are still under study. A contract award is expected in the next few weeks, however.

LINK-BELT P.I.V. is available in all these ways for

super-sensitive quality control



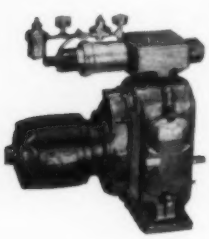
Here's the basic P.I.V. for stepless, slipless speed changing

Today a growing number of production machines and operations demand extremely accurate transmission of power with variable speed control. For these requirements, Link-Belt P.I.V. is available in the many ways shown below—with automatic controls and integral differential to satisfy an infinite number of variable speed applications.

Variable from top speed to minimum speed with no steps, no stops in between, Link-Belt P.I.V. is industry's only chain-driven variable speed drive. Teeth—not tension—permit positive, high-efficiency power transmission.

For information on the full P.I.V. line, call your nearest Link-Belt office. Or write for Book 2274 on basic P.I.V., and Book 2774 explaining P.I.V. with integral differential.

Link-Belt P.I.V. is available in 8 sizes and 16 standard types, in capacities from ½ to 25 hp—for horizontal or vertical mounting. Compact design simplifies installation as a separate unit or a built-in part of a machine. P.I.V. is totally enclosed, automatically lubricated.



PNEUMATIC (shown) — The P.I.V. pneumatic ratio changer is used as a final control element providing fully automatic control of speed. Operates from standard pneumatic controller in systems regulating pressure, temperature, rate of flow, etc.

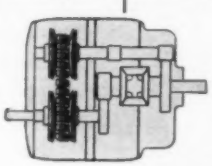
MECHANICAL — Predetermined timing, cyclic, or characterized regulation can be accomplished by P.I.V. with mechanical controls.

HYDRAULIC (shown) — Consists of a low-pressure hydraulic Servo system with a precision valve positioner. Intended to give automatic speed control by direct operation with any form of linkage. A minimum operating force is required.

ELECTRONIC — Flexible form of speed control to provide either "on-off" or modulated speed response of P.I.V. drive. Electric control motors are available to match a wide variety of electrical control systems.

P.I.V. with integral differential gearing

CONDENSED SPEED RANGE TYPE of integral differential results in a ratio range less than a standard P.I.V. with the advantage of increased horsepower capacity, high ratio stability and accuracy. These drives are applicable wherever small ratio range is required but with extreme accuracy of ratio control.



EXTENDED SPEED RANGE TYPE of integral differential results in infinite ratio range and output speeds down to zero with a constant input speed. Clockwise and counterclockwise rotation through zero is also obtainable. These drives may be used whenever a ratio range greater than 6 to 1 is required.

LINK-BELT P.I.V. VARIABLE SPEED DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15,103

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Robbins & Myers Series-Wound (Universal) and Induction Motor Parts can increase your products' life expectancy, whether you make portable tools for farm, home or industry; household appliances; business machines; or other power-driven items.

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Standard R&M Motor Parts are available in a large variety of mechanical details and electrical characteristics. Should performance requirements be unique, R&M also offers custom-designed parts. Write today for Bulletin 445A-PRE.

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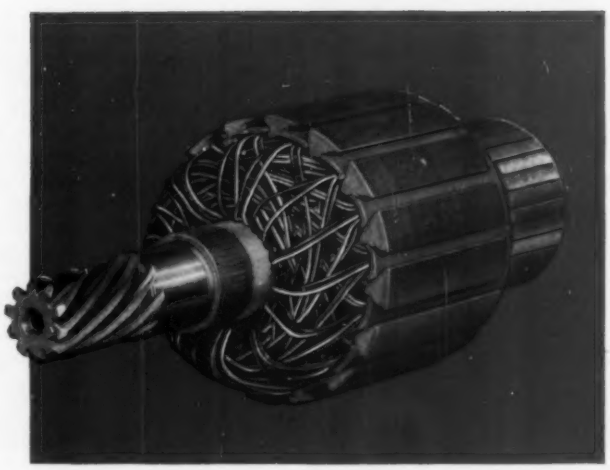
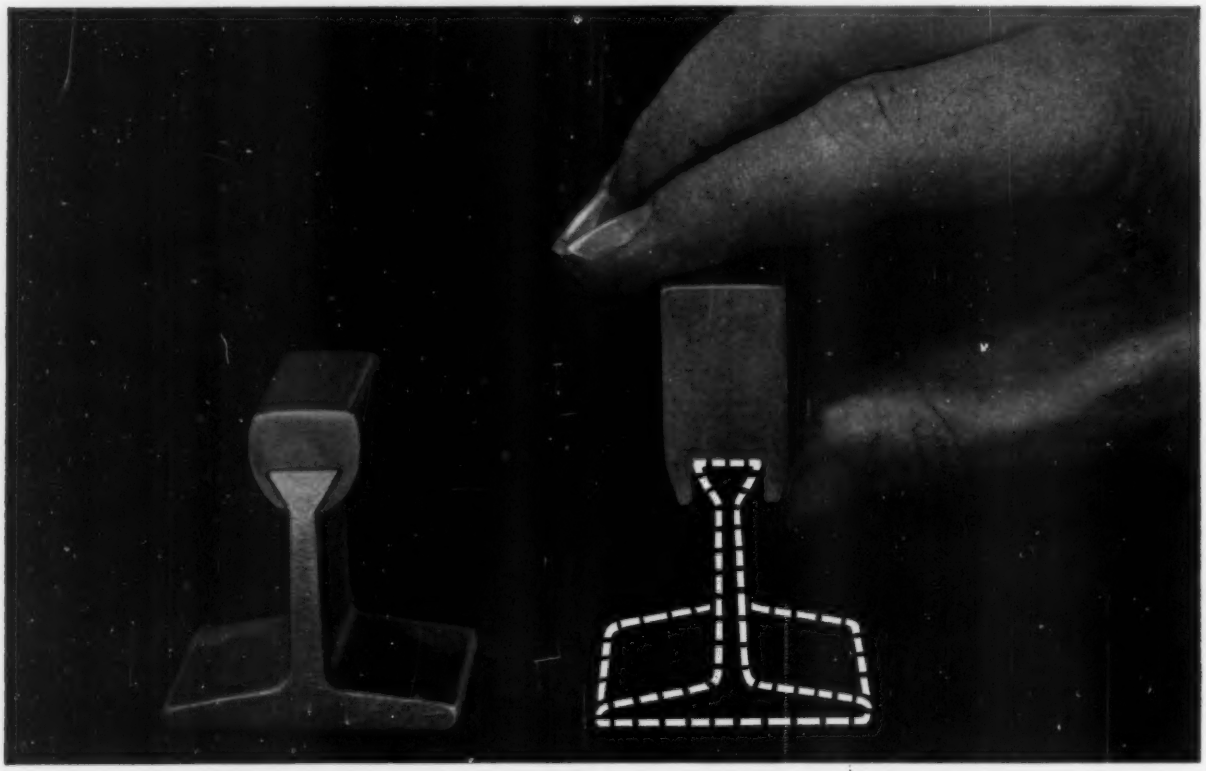
New R&M armature winding techniques provide longer, more dependable service. Coils are wound simultaneously and are exactly identical, assuring identical electrical and physical characteristics. Coils are uniformly positioned and anchored securely. Interlocked winding pattern resists conductor and coil end movement . . . minimizes abrasion of wire insulation, a common cause of high speed armature failure. Maximum coil end exposure permits greater heat dissipation, prolonging armature life. Uniform electrical characteristics reduce arcing at brushes, improving commutation and lengthening brush life.



CIRCLE 13 ON READER SERVICE CARD

COPPER FOR CONDUCTIVITY TEAMS UP WITH STEEL FOR STRENGTH



...in a compact, low-maintenance conductor system for heavy-current industrial applications

The copper-headed steel conductor rails, shown above, of the Ringsdorff Carbon Corp., East McKeesport, Pa., help provide many economies in conductor systems for such heavy-current users as traveling cranes, ore bridges, monorails—using either a-c or d-c.

The heart of the Ringsdorff Current Conductor System—the copper-headed steel conductor rail and pantograph current collector with a graphite carbon shoe. Components, including rail hangers and joints, are available in a wide variety of sizes, with capacities up to 2000 amps, for either a-c or d-c systems

The system is simple and compact. One basic steel shape provides strength and simplifies installation. Over it is cold drawn the copper head of extruded Anaconda ETP Copper-100, in the size to meet individual current requirements. (Copper-headed conductor rail, left, 500 amps; right, 1500 amps.) Less space is needed; installation is easier than with aluminum rails.

Long life and low maintenance. The special Ringsdorff carbon graphite used in sliding contacts has an affinity to copper, putting down a film that lubricates its passage and protects the rails. Wear on the copper head is negligible over periods of 20 to 25 years. Only maintenance is replacement of carbon shoes, having an average life up to 3 years. Aluminum rails must be protected by lubrication or they will wear and pit—when out of use for a period may develop an insulating oxide film.

This is another illustration of the way the unique properties of copper are being utilized in industry to do things better—at lower cost. Anaconda has teams of specialists available to sit down with members of your organization to help select the alloys and forms of metal to solve your value analysis problems. For such technical help, see your Anaconda representative, or write: Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 6147

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THE ENGINEERING WEEK

Air Force Machine Will Start Translating Russian This Fall

The three-part unit is designed to translate technical literature at 100 words per second. Chinese is the next step in this project aimed at meeting the anticipated need to translate up to 4 billion words in 12 languages by 1970.

ROME, NY.—If all goes well, a new era in Russian-language translation will begin this November. That's when a three-part mechanical system —print-reader, translator, and lexical-graphical output printer—will go into service at IBM's new research lab in Yorktown Heights, NY. The experimental model was developed during the past five years by three companies under contract with the Air Force's Rome Air Development Center. Its job will be to translate Russian technical literature for the Air Force.

Both the technical and linguistic problems of mechanical translation have been keenly researched and generously financed by several government agencies in the interval since Sputnik first made the US aware of Soviet technical competence. Most research supported by the Navy, Army, and National Science Foundation has been aimed at compiling dictionaries and analyzing Russian grammar. But the Air Force has concentrated on translating equipment and has diverted about 70% of its funds to support development.

Air Force believes that a practical mechanical translation system needs special equipment, that the fastest way to get an operating translator with an output of readable English is to work simultaneously on hardware and linguistics. Many connected with the Air Force program readily admit that language studies fostered by other agencies are producing insights into Russian that may eventually yield better translations than the ones expected from the new system. But the Air Force system will be turning out translations now, when they are badly needed.

Baird-Atomic is designing the text reader, IBM the translator, and Mergenthaler Linotype and IBM the output printer. This equipment includes several novel design approaches—some of which, Air Force says, may have important applications for other non-numerical data-processing problems, such as mechanical indexing and abstracting. The print reader is built around an optical system, rather than the more conventional graphic on-line processing. The unit is said to be faster and better able to recognize punctuation marks than its counterparts. The IBM translator is a special-purpose unit built around a photoscopic memory device (*PE*—May 23 '60, p 17) was a far greater information-storing capacity than magnetic drum or other types of memory devices. Furthermore the data stored on it can be retrieved at electronic speeds and relayed to other portions of the system. Mechanical-translation research programs elsewhere use a general-purpose IBM computer if equipment is involved.

READING RUSSIAN

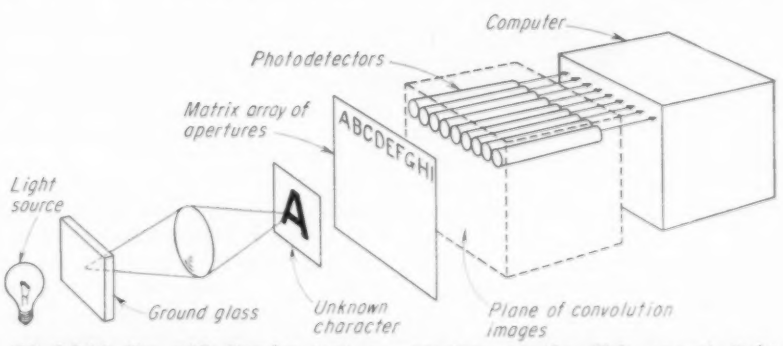
In the Air Force reader being built by Baird-Atomic, Russian text is first photographed on 70 mm film—that way all print, no matter what its original size, can be reduced to uniform dimensions. This film is then read by an optical system which matches text with apertures on a matrix disk. (See illustration.) The disk includes apertures for numbers, punctuation marks, and various letters of the Cyrillic alphabet.

Russian text, like English, is printed in many different type-fonts. Hence B-A has supplied disks for 12 different fonts. The machine automatically refers to other disks when it cannot find a matching aperture. If no match can be found, the machine flashes the problem letter on a screen. With present disks, B-A estimates that its machine can read 90 to 95% of all Russian literature of interest to the US.

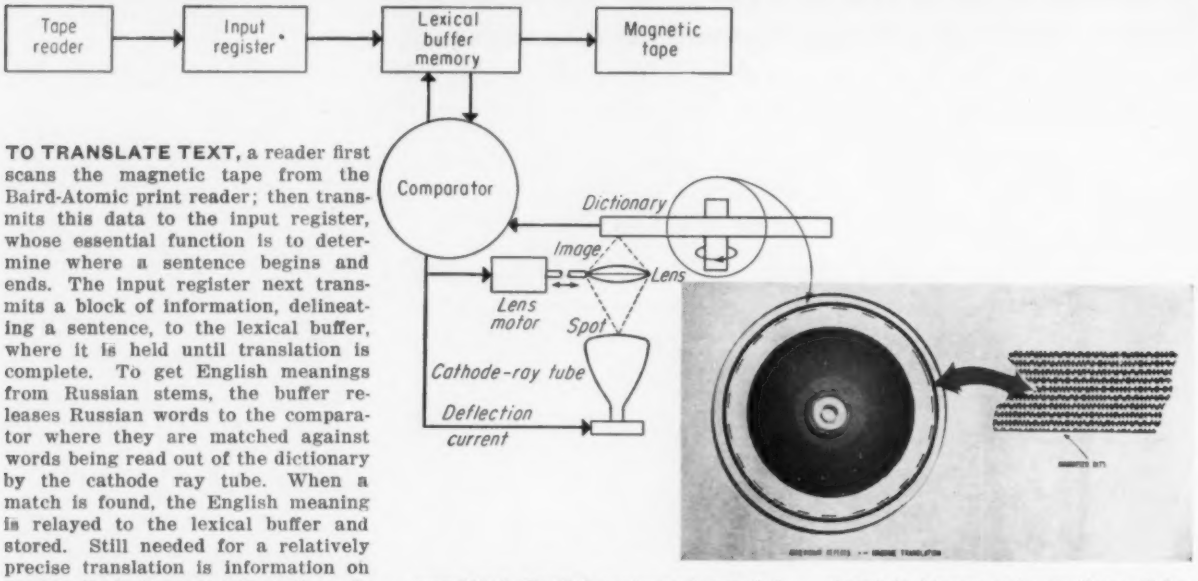
Rome Air Development has announced that this unit is expected to read at about 100 words per sec (about 1000 characters per sec). This is the rate at which an oscillating mirror scans the lines of type. Its sweep rate is 11 lines per sec.

Simultaneous imaging—comparing the film image being read with all the letters and numbers on the matrix disk—makes possible the rapid reading rate. It is done by a series of multiple lenses. Originally, Baird-Atomic proposed a diffused-light source for simultaneous imaging, but practicability later led to a lens system instead.

The reader has apparently overcome one handicap of earlier readers —it can identify punctuation marks and distinguish quite reliably between similar letters ("c" and "e" in English, for example, are often confusing to machines). The machine has two separate optical recognition systems which reduce the amount of light reaching the photoconductors from



TO READ film with Russian text, a light first passes through the transparency to the matrix disk. When image of a letter on the film matches aperture on the disk, enough light passes through to actuate a bank of photoconductors. Their electrical outputs are processed on magnetic tape



TO TRANSLATE TEXT, a reader first scans the magnetic tape from the Baird-Atomic print reader; then transmits this data to the input register, whose essential function is to determine where a sentence begins and ends. The input register next transmits a block of information, delineating a sentence, to the lexical buffer, where it is held until translation is complete. To get English meanings from Russian stems, the buffer releases Russian words to the comparator where they are matched against words being read out of the dictionary by the cathode ray tube. When a match is found, the English meaning is relayed to the lexical buffer and stored. Still needed for a relatively precise translation is information on grammatical characteristics of words in the sentence such as tense, gender, number and position they should take in the English version. To get this information, the buffer keeps referring back to the dictionary, through the comparator, as many as 16 times; on each pass it picks up more grammatical information to clarify meaning. After the original sentence is fully translated, English sentence is printed out on magnetic tape and next sentence is fed to translator. Insert shows closeup of the photoscopic memory disk (the dictionary); it can store 30,000,000 bits (equivalent of about 500,000 words) on a 10-in. plastic disk. Some 128,000 Russian words, their English equivalents and certain grammatical information are at present stored in binary code on these disks. Code is black-white and white-black blocks, 0.3 mil square, arranged in concentric circles. The cathode ray tube directs a light beam through the lens system to the disk. As light sweeps the information track, it passes through the white areas to a photomultiplier tube, which transmits the on-off signals to the comparator.

all but the correct letters. One optical system transmits light in a region having the size and shape of the letter to be recognized, and is opaque elsewhere; the second does just the reverse. There is only one combination of transmitted and reflected light for each character.

THE TRANSLATOR

The Air Force translator built by IBM is now being modified to include a sentence-analyzer—expected to improve considerably the grammatical precision of its translations. The final model will be ready in June. The original translator, the Mark I, began making rough translations of Russian technical literature in the early summer of 1959. It was assembled primarily to test the machine's principle. The follow-on Mark II, now being modified, is a fully transistorized version. The electronic circuits are assembled from Q-packs, developed for SAGE by IBM's Federal Systems Div.

Design of the lexical buffer is raising formidable problems for linguists as well as engineers. Russian is a highly inflected language. Each verb may have as many as 150 different forms; nouns as many as 50, denoting case, number, gender, etc. It would be impractical to include all possible forms for each word in the dictionary. Hence, the problem is to isolate various grammatical endings, which have a uniform effect on a class of words. These isolated endings in the dictionary can be combined with the stem to give a correct translation. The linguists working on the IBM program make no claim that translations will be faultless. Near-perfection, they say, can come only when a semantical capability is built into the machine—then the machine would be able to obtain grammatical information from context of the sentence itself. This goal may take many years to attain.

MAKING THE DISK

IBM has developed special equipment for making the memory disk. First step here is the feat of coding Russian words, their English equivalents, and grammatical information, and arranging them in the proper order for the dictionary. This information is then recorded on magnetic tape, which is subsequently used to operate a cathode-ray tube. A film passing across face of the tube is thereby exposed to the "flash"—"no flash" sequences called for by the tape.

The film is 2½ in. wide, 140 ft long, and contains 54 tracks of information. To fit this much data on a 10-in. disk, the photographic image must be reduced to 1/54th of its original size. This reduction is accomplished by the optical system of a second piece of equipment, which exposes the plastic disk (washed with a photosensitive emulsion) to the black-and-white pattern on the film. The drive mechanisms for the film and disk spindles are coupled to prevent variations in speed. A 140-ft length of film is synchronized to one rotation of the disk; therefore as much information can be squeezed onto an inner band as an outer one.

Development of the disk image must be carefully controlled, for a hair or speck of dirt embedded on the surface could cause errors. Actual photographic development takes place in a pressurized container—developer fluid is applied to the disk surface by hypodermic needle. Project engineers say that smearing, which might be ex-

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SIZE 5

This new line of Allen-Bradley motor control will change every idea you have had about starter size, performance, and life. The small size—especially in the higher ratings—is startling. Yet rating for rating the operating life and reliability have been increased many times. Built into each of the seven sizes of this new Allen-Bradley line is an ability to interrupt tremendous currents and to operate year in and year out for many millions of operations without trouble or maintenance.

The new Bulletin 709 starters are just as advanced in appearance as they are in performance. All seven sizes have an aristocratic styling and a distinctive family likeness. Brooks Stevens, famous industrial designer, has given the enclosures such an attractive, modern style that these new starters will prove a distinct sales asset on any machine or installation.

Why not write today for more information on this revolutionary new line of Allen-Bradley Bulletin 709 *quality* across-the-line motor starters?

Note the compactness of both the smallest and largest starter in the new Bulletin 709 line. Ratings up to 100 hp, 220 v; 200 hp, 440-550 v.

12-61-RM

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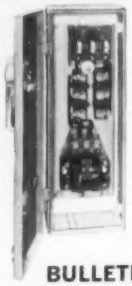
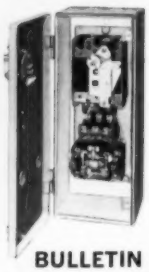
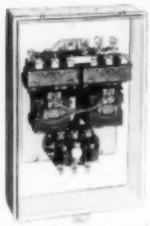


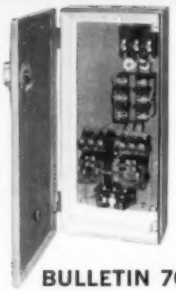
BULLETIN 712
Size 1 combination starter with fused disconnect switch



BULLETIN 713
Size 1 combination starter with circuit breaker

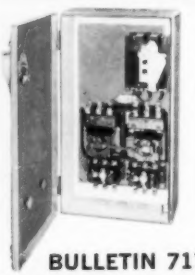


BULLETIN 705
Size 2 across-the-line reversing starter with overload relays



BULLETIN 706
Size 1 reversing starter with fused disconnect switch

BULLETIN 715
Size 1 across-the-line, multi-speed starter with overload relays



BULLETIN 717
Size 2 multi-speed starter with circuit breaker

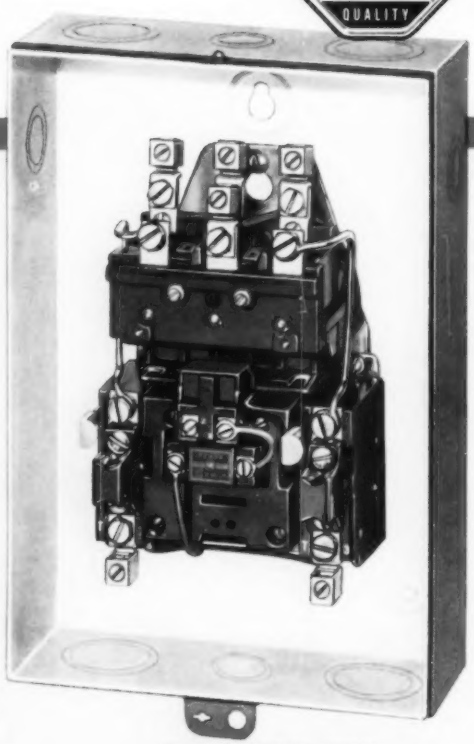
BULLETIN 702
Size 3 three-pole, a-c solenoid contactor

Pygmies in Size
Giants in Performance—
the NEW Allen-Bradley Across-the-Line Starters!

This new line of across-the-line motor starters is the result of over 30 years of experience and leadership in the motor control field.

While retaining the simple solenoid principle—with only ONE moving part—these starters are completely new in every way. They are amazingly small in size—yet test after test has proved they will not only outperform but also outlast any starter now on the market. They are good for *many millions* of trouble free operations. All have scores of design refinements that make them easier to install and maintain. All are available in the smart new enclosures designed by Brooks Stevens. They make a beautiful addition to any machine or control installation.

You'll want to get the complete story about these truly revolutionary new across-the-line starters. Write for new Publication 6100.



BULLETIN 709
This popular across-the-line solenoid starter shows the new Size 2 construction. Note the white interior and generous wiring space. Bulletin 709 starters are available, in the new construction, in seven sizes—Sizes 00 to 5, with a maximum rating of 100 hp, 220 v; 200 hp, 440-550 v.

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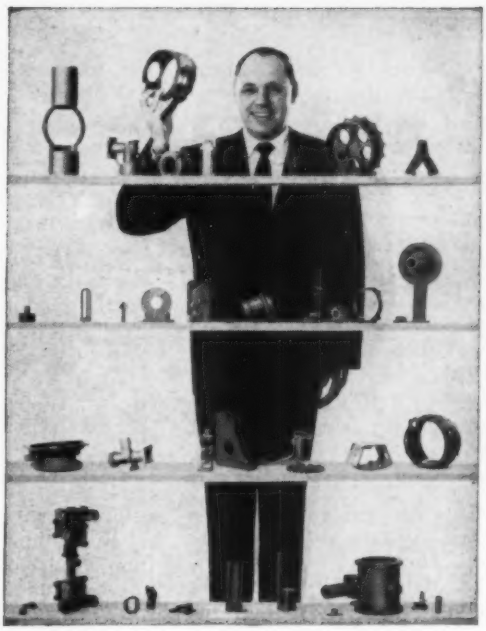

No investment casting job has ever been or ever will be too small for us.

WE DON'T HAVE ANY "SIDELINES," nor is investment casting only a sideline with us. It is the "be-all and end-all" of our economic existence.

AS A RESULT: anybody who thinks that an investment casting will help him solve a problem gets the unqualified, attention of the top talent we have to offer–from our trained field engineers, our design engineers, our estimating staff, our tooling men, and our production specialists. No one of these groups cares whether your order is for 50 parts or 100,000. If they accept the order, they want it handled to or above "specs".

WHY? SIMPLY BECAUSE THESE MEN ARE DEDICATED to producing the finest that the process can deliver in any design, in any castable alloy and in quantities so small that it might surprise you.

THEIR ATTITUDE IS FAR FROM PHILANTHROPIC; they realize full well that your "little ones" may soon grow up.

ARWOOD IS READY WHEN THEY DO... more so than any other investment caster. In fact, we can take in stride all the volume that's required. Our five plants, each fully integrated, can handle the biggest job you can offer.

ONCE THE PROTOTYPE PHASE IS COMPLETED, Arwood can give you the quantity production you need, and deliver it when you need it.

WHAT MORE CAN WE SAY? Simply this. Most "difficult" components, no matter what the alloy or quantity, might well be produced as an Arwood investment casting... and THE COST IS OFTEN EXTREMELY LOW, compared with conventional methods.

ON THE OTHER HAND, IF WE CAN'T DO IT– and do it economically–we'll be the first to tell you so immediately. We'd rather lose an order than a customer. Try us and see.

ARE YOU REALLY UP-TO-DATE ON WHAT INVESTMENT CASTING CAN DO? Our 48-page "Practical Guide" gives forthright answers... tells how to design for the process, gives complete tables on properties. It's yours for the asking.

Machine the simple... cast the complex

A complete service from design through tooling, production and finish machining. Seventy-one engineering representatives from coast to coast.

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pected because the film moves linearly while the disk rotates, is well within tolerance of the translator's reading assembly.

PRINTING A READABLE COPY

The Air Force composer-printer, being built by Mergenthaler Linotype Co, is an adaptation of commercial units now being used to print National Geographic and the New York Daily News. But special problems are involved. A line of Russian text needs 10% more space than English, hence layout of the English version cannot duplicate the original Russian report. Also, halftones, schematics and charts are masked out before the print reader goes to work; these must be reintroduced in the final copy.

In the Mergenthaler equipment, data pertinent to the layout of the illustrative material—such as height and width of the pictures—are punched on paper tape, and the pictures are filmed. This film and tape, and the magnetic tape from the translator, are fed to the compositor. Through an electronic logic, designed by IBM the machine arranges layout of the text and illustrations. These operations include justifying lines so that all columns have uniform margins; specifying type from 108 different sizes and styles; and juggling pictures so they do not overlap with type.

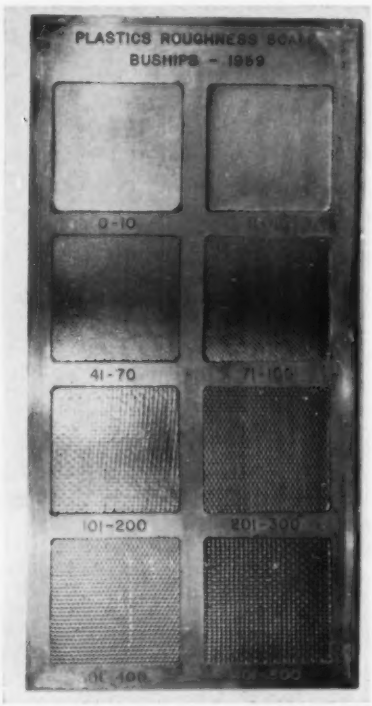
The resulting text and layout instructions are punched on 15-level paper tape which controls a Mergenthaler Linofilm—a medium-speed, electromechanical output printer. On instructions from the tape, this unit selects type combinations called for on the tape, and films the resulting English text, leaving blanks where illustrations are supposed to fit. The illustrations are then projected into the blank areas from the original film record. The completed film is next used to make plates for a photo-offset press. Ultimately some of these manual operations connected with photographing and measuring illustrations, and punching this information on tape will be automated.

NEXT COMES CHINESE

Consistent with its philosophy of simultaneously developing equipment and linguistics, the Air Force is already contracting for equipment to crack the next language barrier—Chinese. Mergenthaler Linotype is now working on a transcription machine for converting Chinese ideographs into electrical signals—9000 characters have been mechanized.

—Dora Merris, assistant editor

Roughness Scale to Check Laminate Samples



This roughness scale for gaging surface characteristics of glass-cloth laminates has been developed for the US Navy by the Dept of Agriculture's Forest Products Lab, Madison, Wis. With it, Navy personnel can visually check laminate samples for qualities required by design specs. The 8 grades into which laminates are classified range from very smooth surfaces, which deviate no more than 10 microin from a mean line, to rough surfaces, which deviate from 400 to 500 microin. Measurement of average roughness of various surfaces was obtained with a stylus-type surface-measuring instrument, known as a Profilometer. Once the scale was established, Forest Products Labs made a master mold for casting the replicates shown left. Be cause a mold cannot be made directly from a plastic surface, a technique for metallizing the laminate was first developed. The surface was sensitized with silver and then plated with nickel. The lab is now working on other scales, including one for woven roving surfaces and one for effects of sanding and painting on surfaces. Navy is developing these standards for guidance of its personnel.

High Grades Help Fledgling Engineers Get Jobs

St Louis—Except for students in the top 25% of their classes, job pickings for college graduates in this area will be much slimmer this June than last. So say placement officers at St Louis, Washington and Missouri Universities after the first round of this year's recruiting activity.

Though a quest for engineers still dominates the recruiters' search, even these favored specialists are feeling the increased emphasis on scholastic attainment. According to Mrs Mildred B. Lee, director of engineering placement, the students are facing up to the challenge.

"Even our engineering students," she says, "realize that the day when an engineering graduate needed only a warm body is over. They have knuckled down and their grades reflect the new seriousness. They are being more selective, too, and want to make the right job choices the first time."

Several of the placement directors here are unhappy about industry's concentration on students with high point averages. Leo Easton, in charge of placement for the business and education schools, warns that one "can't depend upon grade-point average to guarantee the best evaluation of a graduate. Some teachers still delight in giving low grades. I think some of the best term-prospects are in the middle-third of the grade-points."

RECRUITERS STILL PLENTIFUL

Despite their selectivity the number of companies visiting the campuses remained about the same this year as last, though many say they will pare recruitment activities next year. Job offers were fewer; the average per student was 7 compared with 13 last year. But engineers who accepted positions are doing somewhat better than their counterparts last year. At Washington Univ the average engineering salary rose from $530 monthly to $550 or $575.

Placement directors cite other problems in placing their charges. Chief among these is a growing reluctance of companies to hire grads who have not completed military training. Industry caution is even more pronounced this year than last, Dr R. W. Lansford,

director of business school placement at Missouri Univ, has found.

Other schools report difficulty finding positions for alumni who have lost their jobs or want to move to better positions. And the task of placing men over 45 is reportedly becoming increasingly difficult each year, no matter what the applicant's ability.

Ted Schafers, St Louis Bureau

AGMA Sets New Gear Standards

WASHINGTON—The American Gear Manufacturers Association has adopted a new Gear Classification Manual (AGMA 390.01) for spur, helical and herringbone gears. Under this classification, the number of quality classes for fine-pitch gears has been increased from 7 to 16, and for coarse-pitch, from 4 to 16. The manual covers the range from ½ to 200 pitch.

One of the major innovations is inclusion of code numbers specifying gear material, heat treatment and hardness. A typical entry is 10-CH-3. Here, the 10 designates quality number (16 is highest) and indicates a gear manufactured to these tolerances: runout, 0.0014; pitch, 0.0005; profile, 0.0011; lead, 0.0008; and total composite, 0.0019. The CH-3 is the material designation for a gear of carbon steel, carburized and hardened to 55 to 63 Rc.

The new manual has increased backlash ratings from 4 to 5 with the new classification falling at the refined end of the scale. Also, the tables include the amount of thinning applied to the tooth for each class. ■

Engineers Aid Paralytics

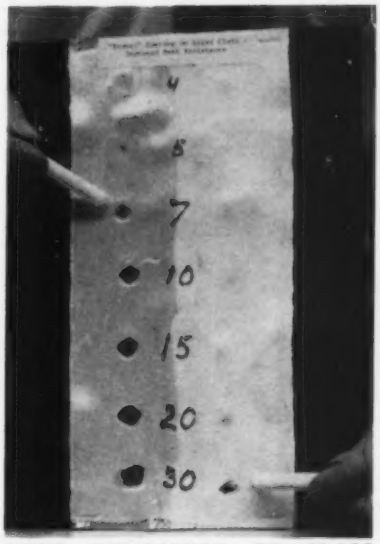
CLEVELAND—A cooperative venture between engineering and medicine is planned here between Highland View Hospital and Case Institute of Technology. As part of the program, two computers at Case will be assigned to diagnostic and research problems. They will handle such jobs as interpreting electrical signals from the heart to tell physicians what disease is present, and studying the electrical signals occurring when a muscle of the arm or hand moves. Such studies will have importance in treating partially paralyzed people.

The engineers and physicians will also investigate applications of memory storage and remote manipulators to partly paralyzed people. Under development is a tiny electronic receiver to actuate a muscle which has lost its nervous connections to the brain. A computer "memory" will supply it with signals similar to those the brain normally supplies. The group is also studying techniques for operating artificial limbs by signals broadcast from tiny transmitters implanted in muscles near the lost limb. ■

New Colloid Upgrades Thermal, Mechanical Properties

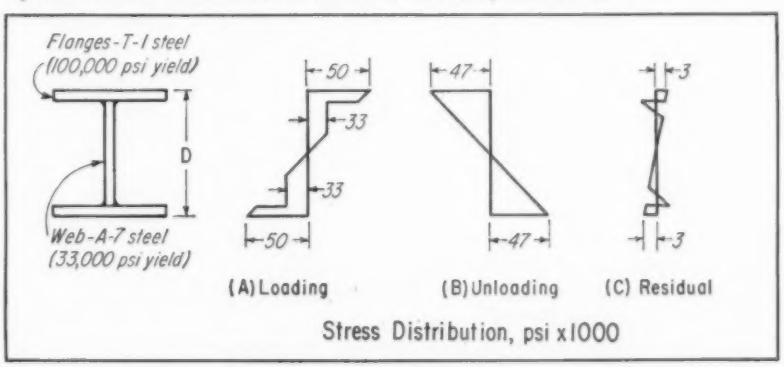
NEW YORK—New coatings for steel, improved refractory felts and fabrics, and a host of new consumer products are foreseen by DuPont as its new Baymal colloidal alumina (*PE*—Apr 17, *p* 8) moves toward commercial use.

It can be used to bond conductive coatings to glass and metal, to upgrade the thermal stability of ceramics. It can serve as a high-temperature adhesive, and it can be used to increase the strength of mica and asbestos products. It can reinforce foam rubber and plastics. It also has unusual optical properties. Now being evaluated by producers of these and many other products, it is in pilot production, can be obtained in 1-lb and lesser quantities at experimental prices. ■



HEAT RESISTANCE OF GLASS CLOTH is improved by DuPont's colloidal alumina treatment. The untreated sample at left, charred and burned through in about 5 sec when exposed to an oxygen gas flame. Treated sample at right withstood the flame for nearly 30 sec.

Hybrid Steel Beam Cuts Cost of Heavy Structures



How can an engineer cut costs with high-strength steel? US Steel offered some suggestions at its recent Engineering and Design seminar. One of these, suitable for heavy structures such as truck bodies or earthmoving equipment, is a hybrid beam with welded flanges of T-1 (100,000 psi yield) and webs of carbon steel (33,000 psi yield). Under initial loading, such beams are unusual because they behave both elastically and plastically. But under subsequent loadings, they behave elastically, though they have some permanent set. In the hypothetical hybrid above, the flange deforms elastically under 50,000 psi loading, while that part of the web loaded over 33,000 psi deforms plastically (A). Unloading is elastic (B), but it leaves a 3000-psi residual stress and permanent set in the beam. By taking advantage of plastic deformation, a designer can make a beam that is 37% lighter and 20% shallower in section depth than its counterpart made entirely of carbon steel. This would mean about a 15% reduction in cost. The hybrid beam has an elastic deflection about 2½ times greater than that of a carbon-steel unit. But this can be an advantage where the structure must absorb dynamic loads.

AN INTERVIEW WITH HENRY DREYFUSS

To get a better picture of the industrial designer and his relationship to engineering, we invited Henry Dreyfuss to lunch. Here is the result of Product Engineering's question-and-answer session.

Do industrial designers merit the professional status of engineers?

The industrial designer's status is a different kind. For one thing, as an objective outsider, he is easily accepted by the executive group, the production group, the advertising department, and the sales department of a big corporation. He is consulted because he knows what the consumer or user wants; that's part of his job. He knows of new materials, and is out in the everyday world perhaps more than the staff engineer. Yes, like the engineer the competent industrial designer is respected and has professional status.

Both engineer and industrial designer contribute to the salability of a product. What form do their respective contributions generally take, and what is the relative importance?

I would hope that the engineer and the industrial designer are becoming closer and closer every day. We like to be called in on a job when it is no more than a glint in the engineer's eye. That's the proper time to consult the industrial designer. The important job of the industrial designer is to be able to express the integrity and usefulness of a product. If the industrial designer can do this he can sell it to other people. However, this can be accomplished only through close liaison between designer and engineer. Talk to any successful designer and you will find he is an articulate individual who can speak an engineer's language just as easily as he can talk to the president of a company. I have often turned down a luncheon invitation with an executive group because I would rather eat with the engineers and talk with them, away from their offices, in an effort to understand exactly what they are doing in product design. Misunderstanding between the engineer and the industrial designer is past because, today, the line engineer knows we understand his language and appreciates the fact that we're trying to help him. In turn, he is anxious to help us.

How would you teach engineers the fundamentals of good design?

We do this through contact and influence over the years; it cannot be done quickly. I believe a young engineer should be carefully indoctrinated about the importance of proportion and design during the early stages of his career. Most of all he should not try to be a do-it-yourselfer and should wisely know when and how to consult the industrial designer. Since some engineering schools teach an industrial designing course, in certain instances a little education can be a dangerous proposition. Many graduates may come out thinking they know all about industrial design when they really know little. This is as unfortunate as if I took a 3-month course in engineering and tried to do the engineering for our client. It is pleasing to know that most engineers read a great deal about industrial design. They respect its importance, and when they have worked with a designer successfully, invariably they're his best friend.

If a manufacturer is given enough money for promotion can he sell just about any kind or quality of product?

In most cases, yes, and I think Detroit is the best example. Last year, the day the new automobiles came out I picked up a copy of a big weekly magazine and counted over 30 full-color spreads featuring automobiles. The magazine looked like an automobile catalog. With the tremendous budgets that can afford this type of promotion one can sponsor TV spectaculars, run a show at the Waldorf, put it on the road traveling the country with beautiful girls. Result—you can sell almost anything.

What about the Edsel?

A situation involving many varied circumstances.

What can the public do about the situation besides not buying?

The public did something about it definitely when they started purchasing foreign cars in depth. This, I believe, certainly had a lot to do with domestic production of many compact cars, which, incidentally, show a real improvement in appearance and exhibit the often hidden talents of the automobile designers.

If the Motivation Research people are right, cars are bought by the women. To what extent do women influence the design of other products?

They are a great influence. Anyone selling a product must consider the buyer; and women do one whale of a lot of buying.

Is the design of products today therefore becoming more effeminate?

No, I'd say more aesthetic. Take our turret-lathe group, for example. We have cleaned it up and instead of its looking like a heavy group of castings, bunched together, we've related the forms. We've made knobs easier to handle, and painted it gray instead of black. I don't consider this effeminate. We certainly realize that a heavy piece of machinery must be more masculine—rugged—than the dishwasher in your kitchen, and this is our approach to design. Conversely, some designs are used equally by men and women—the telephone for example.

What are the design trends? What will consumer products look like in 7 years?

Basically, they're going to be simpler and smoother in design. I also think they're going to be much easier to clean and maintain. Some products will be quieter. I now have a watch that doesn't tick, for example. The fact that this watch doesn't tick is not important, but people are talking about silent watches and their toaster that doesn't tick any more. The toaster was an annoying thing at the breakfast table—as soon as salesmen told people it was annoying.

It is frequently said these days that the purchaser of appliances and automobiles is getting less for his money, especially in durability, performance and safety. Do you agree?

I do to a certain extent, and in specific fields. For example, some household utilities have "jet-plane controls" on them that are completely unnecessary. Yet, the consumer must pay for them, and they are expensive. Furthermore, maintenance is an unwarranted expense. I don't know how this trend originated but I might place some of the blame on the automobile manufacturers. In many cases the consumer is misled to believe that he is buying something new when actually he is not. In such cases the designer is abusing his talents by designing products that are planned for a short consumer life simply by adding "gee-gaws" for the sole service of selling.

What else can designers do?

Collectively and individually they can be of great help to the manufacturer and consumer in emphasizing the tremendous importance of integrity in the over-all design of a product. Today, because of the great strides made in research and development, there is vast new technology available to the designer. Consequently, there is really no need, or time, to apply the unnecessary buttons and decorations to sell a product. Yesterday there was the washing machine and dryer, two units; today through advanced knowledge and modern manufacturing techniques the two are combined into one.

POINTS OF VIEW

Henry Dreyfuss with PRODUCT ENGINEERING editors, left to right: Tangerman, Kolb, Dreyfuss, Leerburger, Kelleher.

The designer can help the manufacturer find additional uses and markets for his products. Telephones today can answer your doorbell; tomorrow, they will be doing many other jobs that will cause us to wonder how we ever got along previously. In some cases the industrial designer will hold the hand of the manufacturer and refine his ideas, but in many other cases he will be the objective outsider who will immediately spark an idea that, for some reason, had never been considered.

Do you think there is such a thing as a national look in product design? An American look, an Italian look, etc.

At one time you could recognize a Dutch design as opposed to a Danish or French design. Recently, while in Milan, Italy and walking through the stores, I couldn't tell the difference between anything—everything looked alike. It is purely a case of economics, I believe, that has caused the European designers to try and make everything appeal to the American dollar in Europe. The success of the Detroit look, which concerns me as a designer, has filtered down into the home utilities until an electric washing machine today looks as though you could use it to sink a submarine if you knew the right button to push.

Of course, there are some design trends which people believe are invented by the industrial designer. This isn't true. In fact, whenever the designer tries to push any kind of trend he usually gets into trouble. New trends just don't happen—they are a natural outgrowth of what is happening around us, and a good industrial designer must translate them into successful products.

Henry Dreyfuss launched his career, as a theatrical designer, at the age of 19. Six years later he opened his first industrial design office. Today, Dreyfuss has offices on both coasts and is working with industry and government on such diverse products as telephones, ocean liners, turret lathes and missile launchers. When not actively designing he may be found teaching design at CalTech or UCLA.

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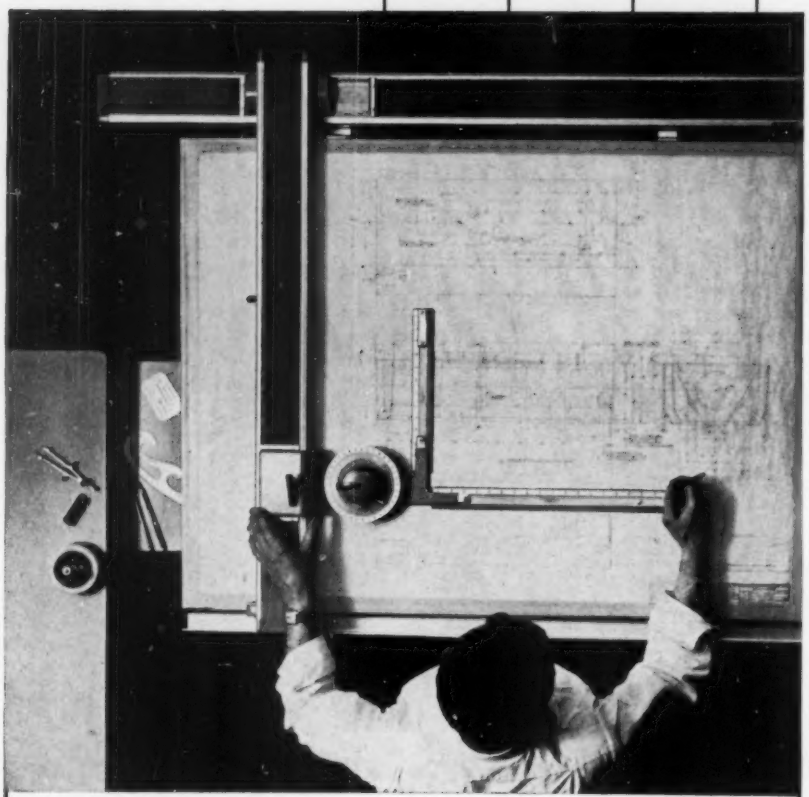

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READER TO EDITOR

SCR vs Thyratrons

To the Editor:

Your article, "SCR vs Thyratrons," Mar 20, p 78, clears the air to a considerable extent by putting the whole question in better perspective. There are two very important points that still do not stand out as much as they should.

1. The voltage problems with SCR's are much greater than indicated by the article. All our customers who are working with both thyratrons and SCR's have concluded that SCR's can be destroyed by voltage transients of such short duration that it was not known they existed. Tubes are insensitive to such transients, will ordinarily operate properly and in nearly all cases will not be damaged whereas SCR's may be destroyed. As a result, it is the practice in a number of companies to derate SCR's by a factor of 2½ or 3 to 1 as far as voltage is concerned. This is a tremendous handicap when you are trying to deal with voltages for which industrial plants are wired—ordinarily 480 volts.
2. There are many tube applications where large numbers of thyratrons have proved to have average lives of many years—longer life than the total time the SCR has been on the market.

—John H Hutchings, *President*
National Electronics Inc
Geneva, Ill

Creative Comments

To the Editor:

I recently read Product Engineering's reprint of the series of articles on Creativity.

Creativity is to be exploited. Unused, it is worse than useless, not even decorative. But it is doomed, apparently, to be mostly unused, unexploited, unappreciated. Look around at the companies that boast of their progress, their record of new inventions, their advances in recent years. So much of this is really sham, illusion, and tailfins, products of overblown publicity, that it all raises a vision of people impressed with themselves alone. Most of these companies that brag of progress can show nothing basic; all they produce is variations on previously stated themes, touted to the heavens by press-agentry. There are notable exceptions, I must admit, but in such cases they have carefully manned their personnel departments with people who can spot creative individuals at a glance so they can reject their applications before they get to the people who want to hire such personnel.

Why is it that synthesis (creativity, if you will) is so often subordinated to analysis to such a degree that analysis rules and precedes synthesis? The analyst, or analytical type of engineer, tells the designer, or creative type of engineer, not only what he wants to accomplish but how he wants the job done. This effectively eliminates the need for the designer and reduces him to the status of a layout draftsman. Such action may inflate the ego of

the analyst, but is it any wonder that the frustrated designer is almost universally recognized as a rebel?

If a company would learn to find out who is creative, without grading of a man's drawings, or using other yardsticks of relatively inconsequential abilities, the company could begin to place itself in a position to whip its competition so soundly that it easily could project long-term leadership in its field. But management is too little concerned with creativity. How often is this talent extolled in managerial publications? How aware is management of who creates its products? Putting it more bluntly: who gives a damn?

Has management succumbed to the philosophy so thoroughly preached today of conforming to the norm, of sycophancy and coattail-riding, of the supremacy of the least common denominator, that it cannot see where its own best interests are? How can industry progress without new ideas, inventions, applications, while discouraging all such creative effort through taking the attitude that, if a designer is so far down in the company, how can he be of any use? Is there any sign that industry is wakening? If there is, let me know; I'd like to go to work, for a change, instead of to a job.

—W Donald Kuntz
Bridgeport, Conn

COMING EVENTS

MAY

22-25 . . . . American Society of Mechanical Engineers, Design Engineering Conference & Show, Cobo Hall, Detroit

22-26 . . . . American Society of Tool & Manufacturing Engineers, 1961 Convention, Statler Hilton Hotel, NYC

JUNE

4-7 . . . . American Gear Manufacturers Assn, Annual Meeting, The Homestead, Hot Springs, Va

5-8 . . . . Instrument Society of America, International Instrument-Automation Conference & Exhibit, Royal York Hotel, Queen Elizabeth Hall, Toronto, Canada

5-9 . . . . Society of the Plastics Industry, 9th National Plastics Exposition & Conference, Hotel Commodore, Coliseum, New York City

11-15 . . . . American Society of Mechanical Engineers, Summer Annual Meeting, Statler Hilton Hotel, Los Angeles

11-16 . . . . Society of Automotive Engineers, Summer Meeting, Shoreham Hotel, Washington, DC

For a listing of addresses of societies and associations send 25¢ to Product Engineering Reader Service Dept, 330 W 42nd St, NY 36. Ask for brochure R 32.

Which coupling cuts costs?

All of Waldron's many types will reduce maintenance and operating costs, and Waldron's engineers will help you specify the best one for your power transmission, whether the drive is big or small.

Type	Bore	Max. torque inch-pounds	Max. rpm
Standard Gear Series A	½ to 7½	716,310	12,000
Francke Pin Type	⅝ to 10½	567,000	4,000
Nylon Gear Series M	½ to 2	2,200	5,000
All Nylon Series J	⅜ to ¾	100	10,000
High Speed Series HS	½ to 8	1,197,000	70,000
Cutout Coupling Anchor-Waldron	½ to 2⅝	5,200	3,000
Cutout Pulley Anchor-Waldron	⅝ to 2⅝	17,500	2,400
Heavy-Duty Gear	4 to 13	2,520,000 5,000,000	St'd 2,000 Forged 4,000
High Misalignment Series X	1 to 6	400,000	6,500

This is merely a sample of the Waldron line, which also includes mill motor, floating shaft, Jordan, shear pin, vertical, spacer, oil collector, marine, brake wheel, and continuous lubrication types. Write for catalog or data sheets on the types you are considering.

WALDRON Couplings

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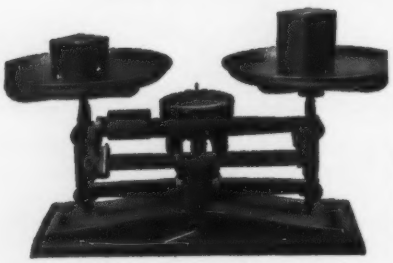
KENNERTIUM*

...a new alloy 50% heavier than lead



Both blocks on the scales weigh the same. However, the lead block on the right occupies 50% more space than the cube of Kennertium at the left.

Usually, when high density or concentrated mass is desirable . . . small volume is, too. Ballasts and counterweights for missiles and jet aircraft, for example, must often fit very small areas. For these and many similar applications, Kennertium—a special blending of tungsten and other elements—is now being used.

In the above photograph, the block on the left is Kennertium . . . the one on the right is lead. For equal *volume*, Kennertium provides 50% more weight than lead. The high specific gravity of the material makes it particularly suitable for counterweights on the wings and empennage of aircraft (below right).

Used as a radiation shielding material, Kennertium (containing over 90% tungsten) is more effective than other materials.

Still another use is for high rotational inertia . . . such applications as gyroscopic rotors and torsional vibration dampeners.

The piece shown above left indicates the excellent machinability of Kennertium. It also has high malleability (10% elongation) at high tensile strength (115,000 psi). For more information, send for Kennertium Properties Booklet. KENNAMETAL, INC., Department PE, Latrobe, Pennsylvania.

*Trademark 34227

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FOR YOUR INFORMATION (personal)

Complex numbers simplified

A complex-number sliderule that multiples and divides by vector addition and subtraction has been designed by D J Whythe of England and is now being made by W F Stanley & Co, New Eltham, London. Logarithms are engraved on the cylindrical slide, and results are indicated in both rectangular and polar form. The instrument mounts on its case, as shown; is 4 in. dia, 17½ in. long when closed. The price: about $60 (US equivalent). —ARG

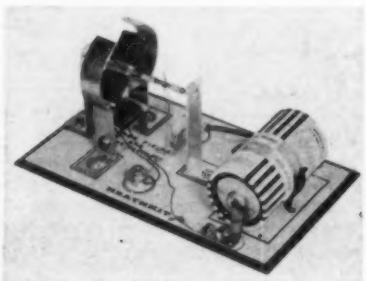
This light switch ponders

A photosensitive switch that will turn the lights on when needed—even if the preset hour has not yet arrived—is being introduced by Tork Time Controls. It's so educated, as a matter of fact, that it can't be fooled by a passing cloud. The light has to drop to between 2 and 4 foot-candles, and stay there at least half a minute, before the switch goes into action.

The new system is a combination of a photocell (for outdoor mounting) and a time switch (inside). The switch is a mechanical, delayed-action unit (to foil the passing cloud), electrically connected to the photocell. Tork says it's the first to combine mechanical switching with light-sensitive controls.

Electricity for beginners

A simple electric kit, designed to demonstrate electric forces, polarity, and magnetism for the nonexpert, is being introduced by Heath Co. Modestly priced at $4.95, it includes all the parts needed to assemble the system pictured—magnet and magnet wire, mounting base and brackets, and an instruction leaflet. Also available: a small magnet set, with wood base and rods for holding ring magnets, plus iron filings and instruction book. Price: $2.95.



Model planes—faster, smarter

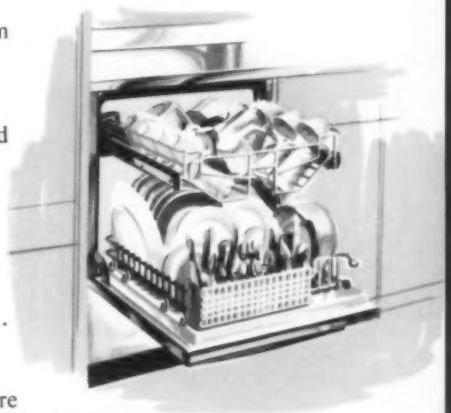
With transistors and new midget motors, model airplanes will really be taking off this summer.

For June introduction, Aurora plastics is readying replicas of Trophy racers (wingspans 14 to 17 in.) that will zoom at speeds to 85 mph. They're powered by K & B 0.49 Tornados. Price: $9.95 each.

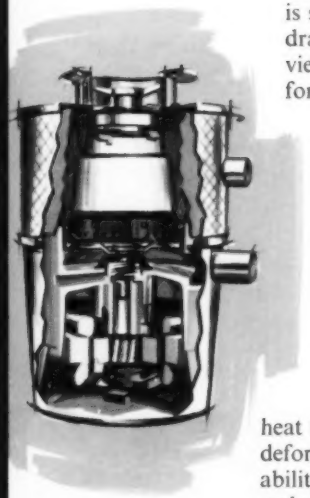
At the same time, Wen-Mac Corp has half a dozen new planes in the $9.95 price range and a transistorized-radio remote-control ground-air guidance system that will summon them on command. The unit, says Wen-Mac, is barely a fraction the size of those now on the market. It's priced at $69.98 for a complete kit containing transmitter and receiver. —ARG

Allegheny Stainless
for beauty with a function

For sinks and hardware . . . stainless steel, the logical choice. Here is an application where Allegheny Stainless can really shine, literally. Under the roughest use, under the battering of heavy pots and pans, under constant detergents and grease residue, the stainless surface remains unblemished, free of nicks or chips, and no corrosion or dark stains from chemically treated water, either. Stainless is easy to fabricate and finish, too. The new, special quality stainless steels now available make tough draws like bowls, drains, and baskets a simple matter. And, stainless can be the most economical metal for plumbing fixtures and hardware . . . looks better, longer, too.

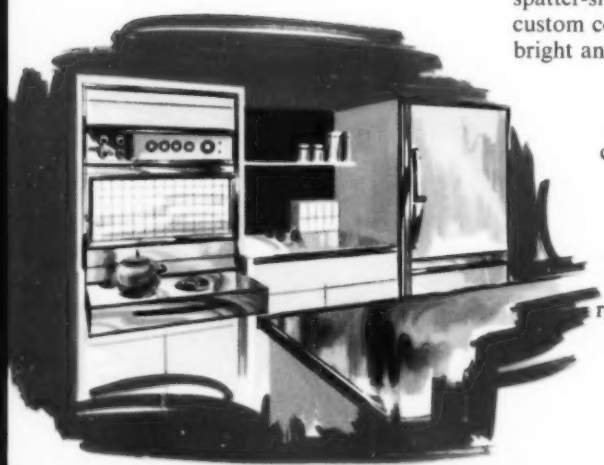


With automatic dishwashers . . . there is freedom from a thankless task. Stainless steel helps keep it that way. Only pump impellers of stainless steel can be trusted to deal out the Niagara-like rush of water needed to power-wash and power-rinse dishes really clean. And with Allegheny Stainless, there's no corrosion, no erosion, no chance of staining dishes. There are stainless guides and channels to insure easy, no-stick operation of the door and trays. There is stainless out of sight . . . in manifolding, seals, seats and drains . . . for real peace of mind. There is stainless in plain view . . . door fronts, counter-high tops, hinges and hardware . . . for ease of cleaning, and long lasting, tasteful elegance.



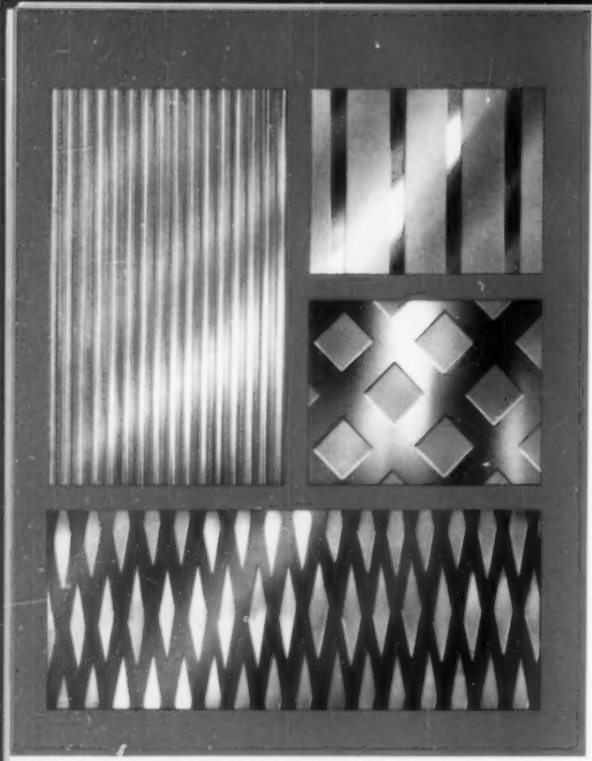
For garbage disposers . . . another thankless kitchen chore where long wear, sanitation, and corrosion resistance are absolute musts. Stainless steel's unique properties . . . excellent machinability and retention of hardness, corrosion resistance, and joint strength after welding or brazing . . . have proven ideal for this application. Whether in the flywheel, the cutter ring, the inner shell, or just for appearance's sake, Allegheny Stainless is unsurpassed . . . by any standard of comparison.

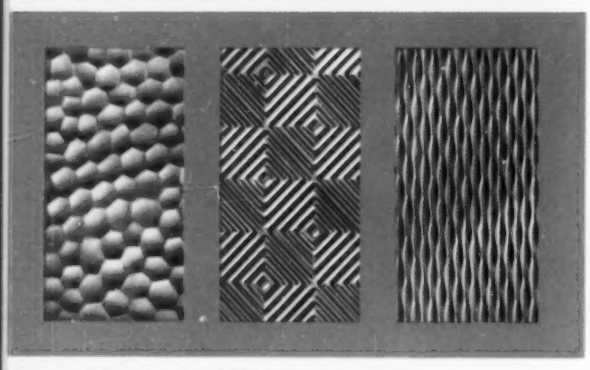
For heating coils . . . Type 332 Allegheny Stainless sheathing provides heat and scaling resistance to 1650 F. For high strength at red heat to support the heaviest pots and pans without deforming, for sliding wear resistance and ultimate cleanability, for economy in high wattage surface units or low wattage oven units . . . for all these reasons, stainless steel and kitchen heating are inseparable. But stainless has more to offer . . . a flash of brilliance in the trim ring around the burners—odor-free, wipe-clean drip pans under the burners—decorative wall tile spatter-shields—an entire custom cook top, gleaming bright and utterly impervious.

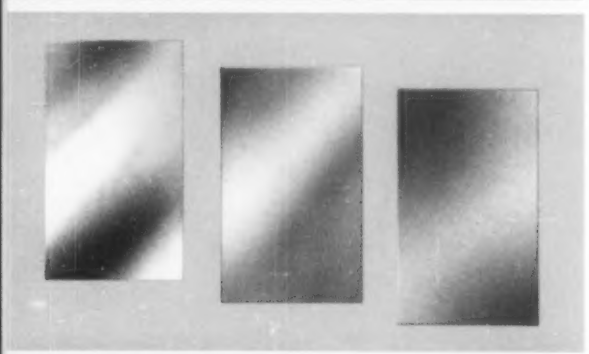


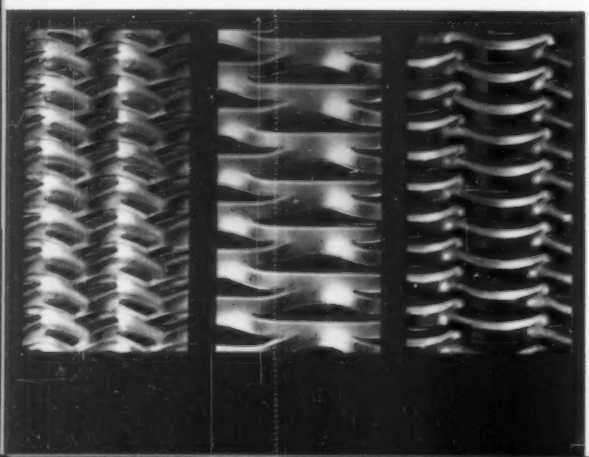
For decorative panels . . . for door-fronts and gleaming accents, for strictly show and for practical, chip-proof, scuff resistant beauty, too . . . stainless steel simply can't be topped. More than a coating . . . a plating, even . . . Allegheny Stainless is stainless utility and beauty clear through. Whether a soft, frosty luster is indicated by the final decor . . . or a brilliant mirror's shine, or any kind of rolled-on pattern you can dream up . . . stainless steel by Allegheny Ludlum can do it better, for longer, and for far less than you think.

Appliances and Allegheny Stainless









IDEA STARTERS

Patterns An endless variety of decorative surface patterns can be mill-produced on Allegheny Stainless Steel. Generally achieved by specially prepared rolls, these patterns are often extremely practical as well as ornamental, serving to protect and stiffen the decorated panel, and to diffuse reflected light in interesting and useful ways. Virtually any design that can be drawn on paper can be reproduced on stainless steel.

Aside from its practical aspects, A-L patterned stainless also serves to broaden the scope of a designer's imagination. It can be used gracefully to break up large, flat areas of stainless panels, to cause the eye to focus on one aspect of an appliance design over another, and to emphasize or minimize shape and apparent dimension. Patterns can be obtained over any surface finish, and unlimited combinations of mirror-bright and softer lusters are possible. For light weight and freedom from dents and scratches, let Allegheny Ludlum show you what patterned stainless can do for your product line.

Textures Where even greater strength, stability, and resistance to warpage and "oil canning" are required, a wide variety of heavily textured or Rigidized patterns is also available. These textured impressions, either unidirectional or multidirectional, are considerably deeper than those on patterned stainless and have a marked stiffening effect on the decorated panels, permitting economically lighter gages of Allegheny Stainless to be specified.

Finishes The appliance maker is limited in his choice of stainless finishes only by the degree to which fabricating and joining marks must be blended into the final appearance of the surface. Available Allegheny Ludlum finishes cover the complete range from frosty white through a brilliant mirror shine, with the softer finishes permitting more grinding, buffing, and blending to remove all trace of weld beads, scratches, and other fabricating marks.

It is a highly questionable practice, however, to habitually specify mirror finishes, and especially to attempt a glass-like polished flatness in large areas. An appearance of waviness, even on exceptionally true surfaces, inevitably results due to light reflectivity. Highly reflective finishes also tend to reflect light as a sharp line image at right angles to the lay or "grain" of the polish, and may tend to introduce distracting elements into an appliance design.

These difficulties are eliminated with the softer, brushed finishes, whose frosty white gleam can be integrated beautifully into any design treatment without regard for reflections.

Expanded Stainless Many designs are now incorporating the beauty of Allegheny Stainless in the relatively new, functional form of expanded metal. To all the useful attributes of stainless steel, expanded metal can add the ability to control admission of light, heat, liquid, semi-solid, gas, and sound to or from any enclosure. For the more practical applications, expanded Allegheny Stainless can be utilized as baskets, guards or gratings, operating in any environment and under service conditions that would ruin other materials entirely. For purely decorative uses, the gleam of stainless can be retained in the expanded grid-like pattern to add soft or sparkling accents to door fronts, vents, and other functional appliance openings.

. . . for your design notebook

An important service which Allegheny Ludlum extends to the American metalworking industry is the maintenance of one of the country's finest research and development organizations to search out new methods, new steels, and new ideas. Many of the recent developments should be of considerable interest to the appliance industry.

TYPE 430 The phenomenon of roping is an excellent example. Some appliance fabricators were running into a furrowed, wrinkled appearance in their product after severe stretching operations. Aside from heavy mechanical polishing to remove these lines or "ropes," rejection was the only alternative. A-L's solution was a combination of processing and alloying steps which produced uniform ductility across the strip. A-L Type 430, low roping quality, is already in use throughout the country. It's worth investigating.

BRIGHT ANNEALING Speaking of polishing, it used to be necessary to buff up the surface of the strip because of the dulling, pickling treatment employed to remove oxide after mill annealing. Not any longer. Allegheny Ludlum's bright annealing process has been in full production since November 1, 1960, annealing stainless in pure, dry hydrogen on a tonnage basis. No oxidation, no surface-dulling pickling needed to remove it. The bonus is a clean, bright surface ready for fabrication with little or no buffing needed. For a really pretty shine, ask your A-L man to show you a #2 Bright Annealed finish sample.

A-L 433 There's even a new steel to try on your tough corrosion problems. Tentatively called A-L 433 and patent applied for, this copper-moly modification has the greatest corrosion resistance of any straight chromium stainless steel. Developed from Type 430, and available now at no price premium over the standard 430, A-L's new 433 is especially suited for applications where contact corrosion has been a problem.

AND, here are other developments worthy of your notice:

There is much going on with stainless steel cladding. There are flat disc cooking surfaces in the works made up of a stainless-copper sandwich with heating coils nestled inside. Its most obvious advantage is more efficient transfer of heat to pan bottom, plus better looks. Cast griddles are coming in for their share of attention, too. There's considerable interest in a thin stainless cladding to improve the appearance and the functional surface finish, and to eliminate buffing the castings.

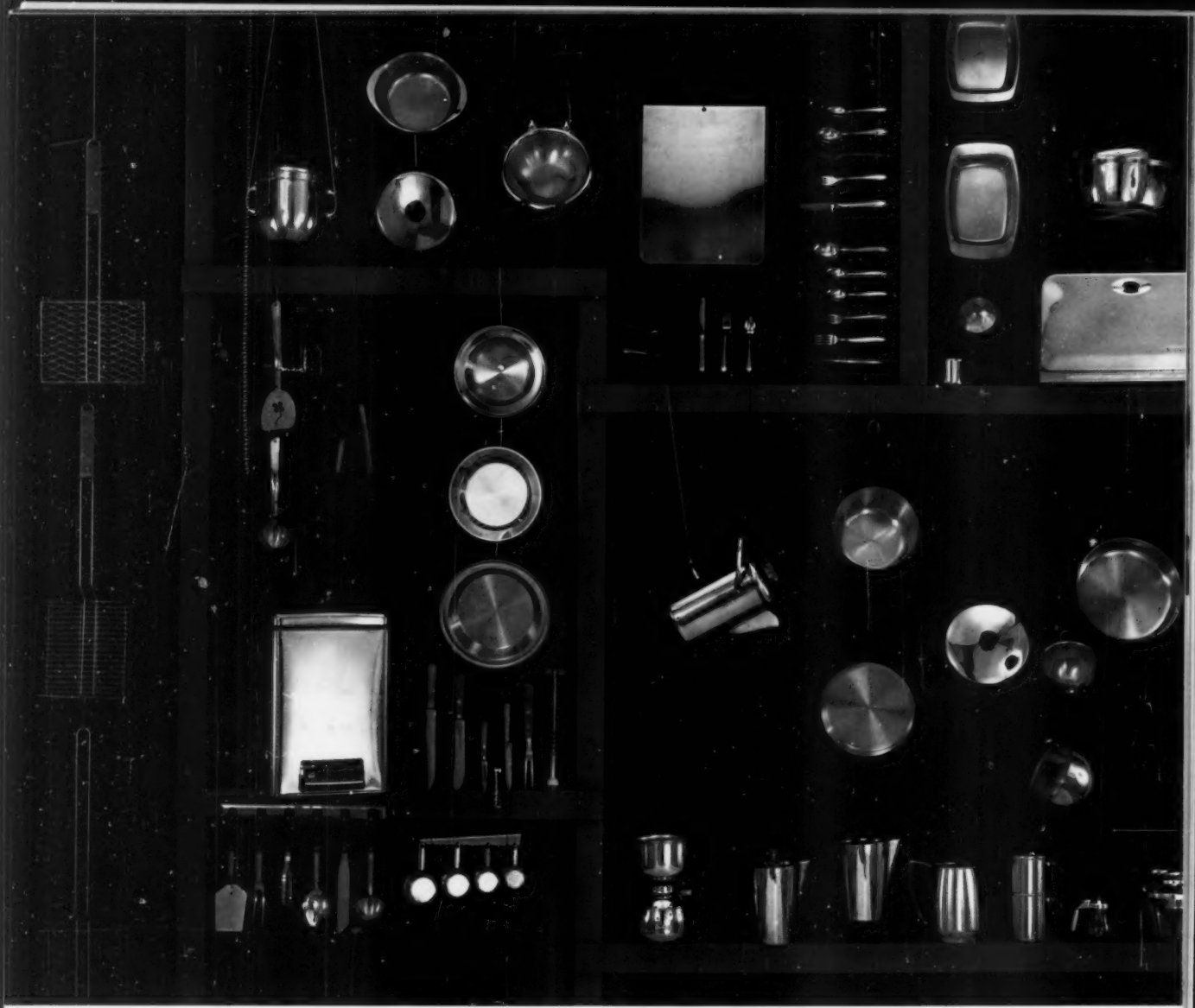
There's a coating under development that has a lot of people wondering. It's destined to make finger-marking and water spots on seldom cleaned stainless a thing of the past. Maybe, it will be used in much handled areas. But, more important perhaps, it has one other extremely interesting ability. It can retard heat tinting on stainless grades not otherwise immune to this disqualifying characteristic. This makes it ideal for oven liners, since it will produce a surface that is bright and reflective, and will stay that way through years of carefree resistance to spilled-on, baked-on foods. And, it should be valuable in preserving the gleaming good looks of functional range hoods and kitchen exhaust system components.

All these things come out of research. All are new or fairly recent developments. All come from Allegheny Ludlum, the acknowledged leader in research in the specialty steel industry.

But, there's more being done, and much more yet to be done. There's interest once again in stainless wire . . . for refrigerator and oven shelving, for freezer baskets, for springs, fasteners, and other applications. Strong enough to permit considerable reductions in bulk and weight, stainless steel wire is moving back into its rightful place in the kitchen once again.

There's work being done with new stainless applications . . . with jobs that only stainless can perform, like the developmental dishwasher with built-in garbage disposer. And all this work is being done with Allegheny Ludlum as an active, interested partner, keeping pace with the needs and desires of the appliance industry, working with the appliance maker and backing him up with the A-L team of research and service specialists, unmatched anywhere. If you could use an experienced, helping hand with your metal problem, *your* A-L development specialist is only a phone call away.

Appliances and Allegheny Stainless



Large or small . . . by the ounce or in 25 pound slices . . . stainless steel offers the same lustrous beauty and honest utility to custom kitchen builders and gadget makers alike. Sparkling, easy-to-keep-clean kitchen utensils of stainless steel will keep their display counter shine in spite of constant exposure to kitchen acids and stains. Whatever the job, however often or infrequently the utensil is scoured and cleaned, stainless steel will keep it bright and shiny, ready for the close-up scrutiny of the most fastidious housewife. Eat from it, drink from it, or boil your coffee in it . . . you can depend on it when it's Allegheny Stainless . . . practical, functional, elegantly indestructible.

ALLEGHENY LUDLUM STEEL CORPORATION

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EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

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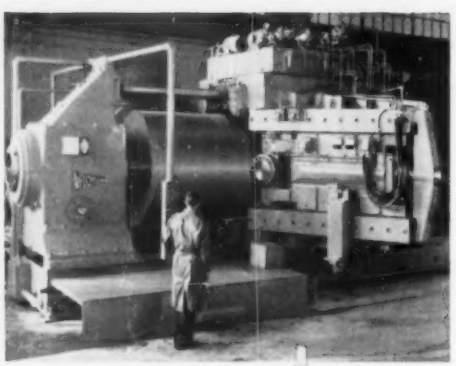
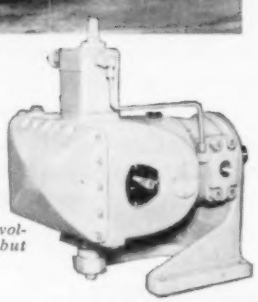
How **LODGE & SHIPLEY** get smooth, variable feed control with **DENISON** hydraulic power on new machine designed for...

SHEAR FORM





SHEAR FORMING MISSILE SECTIONS *up to 70" in diameter, 140" long is done on new 190,000 lb. FLOTURN® machine made by The Lodge & Shipley Co., Cincinnati. Denison Series 800 Variable Volume Piston Pump (shown at right with pressure compensator control) varies output volume to maintain fixed, but adjustable, pressure.*

HERE'S ONE of the largest horizontal shear forming machines ever built. This 150 hp giant was developed by Lodge & Shipley to handle the tough metal forming job of flowing ultrahigh-strength forged steel rings into rocket cases for the Minuteman ICBM. Their new FLOTURN® machine does the work faster than the previous method . . . saves materials, too.

Lodge & Shipley designers faced this key problem: how to provide variable feed control of all carriage movements without use of gears or belts. High efficiency and low heat conditions were additional drive system requirements.

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This is the kind of problem your Denison Hydraulic Specialist can help *you* solve. Working with you at the design stage, he can show you how Denison hydraulic power can help break engineering bottlenecks, improve your product and cut costs. Get in touch with him *now.*

DENISON ENGINEERING DIVISION
American Brake Shoe Company
1194 Dublin Road • Columbus 16, Ohio

HYDRAULIC PRESSES
PUMPS • MOTORS • CONTROLS

DENISON
HYDRAULIC POWER

MAY 22, 1961

THE FOOLISH SERVANT

The Bible tells of the foolish servant, who buried his talents in the ground, while his wiser companions put theirs out at interest during the husbandman's absence. When he came back, they had something to show for their time. They had risked a little and gained much. . .

Ministers of churches where executives go should take this as their text, pointing out that recessions, then as now, are abetted by those who bury their capital to protect it, thus have nothing new to sell. To put their talents out at interest—to back new ideas—takes creative management, an eye on the future instead of on the comptroller, the balance sheet and the market price of company stock.

Little companies have few resources, but to grow they risk much and gain much. Then, when they're big, they develop a fraternity of conservatives who take no chances, where "drivers are tolerated, doers are slightly suspect, and creative people are generally considered to have loose wrists," as Walter Guild said at an American Marketing Assn meeting in Los Angeles recently. He went on to delineate this fraternity's private anti-creative language, in which "new" means "radical," "different" means "unsound," "original" means "dangerous," "expansion" means "merger," and "creative" means "screwball."

In this atmosphere, there is no room for creative ideas; new ideas are not really welcome and creativity is disturbing—an absurd paradox when we are worrying about foreign ideas that enter our markets, about electronic brains so good they become psychiatric problems, about putting men on the moon to help us step off into space.

We are, to put it bluntly, afraid to take a real chance. And this is not a characteristic of management alone; most of us have become herd-bound worshippers of the obsolete, the traditional, the antique. We want some one else to ride the moon in grandma's rocker, protected by a policy issued by Lloyds of London. Begaud, don't originate; copy, don't initiate; keep to the well-worn path, don't strike off across country. Don't hunt your own meat; have it brought sliced, pre-cooked, quick-frozen and wrapped in cellophane. "Hello, where are my slippers, and what's on TV?"

The Bible, to be sure, also says that there's a time to fish and a time to mend nets, a time to prune and a time to gather grapes, but it advocates neither net-mending nor pruning when the growing season is upon us. "As ye sow, so shall ye also reap."

EATON
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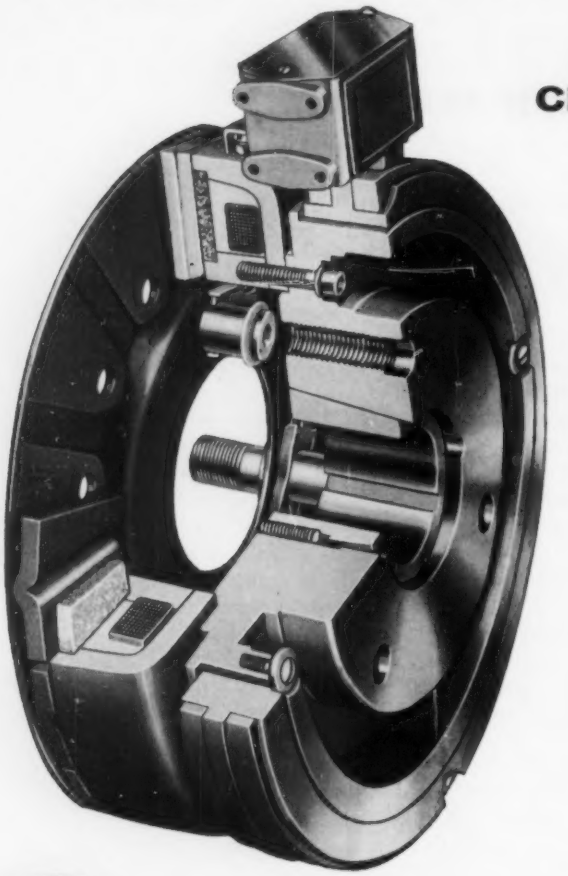

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These highly responsive, trouble-free units provide accurate control of intricate automatic machinery. Operating on 6, 12, 24 or 90 V.D.C., Dyna-torQ units may be actuated by micro-switches, photo-electric cells, relays or any "ON-OFF" signal to perform a wide range of functions in processing and fabricating applications. The compact rectifier type control converts AC power to DC power and may be remotely mounted out of busy machine areas.

Eaton Dyna-torQ Clutches and Brakes are available from 1¾" through 15" in diameter. They may be easily and quickly installed on either new or existing plant equipment. Exclusive features of design and construction mean worthwhile savings.

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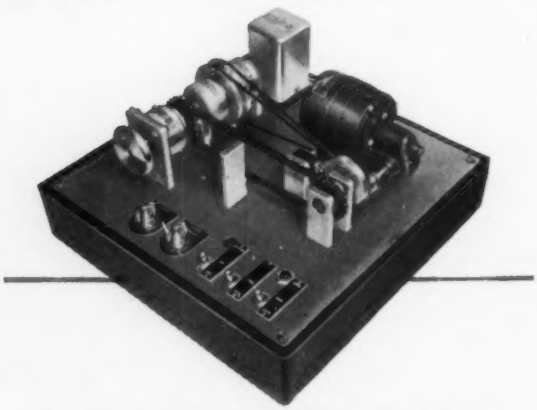
MODEL	HP	MODEL	HP
302	1/20	308	7½
303	⅓	310	10
304	1	312	20
305	2	315	25

Dyna-torQ Distributors in many principal cities carry Dyna-torQ Clutches and Brakes in stock for immediate delivery.



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PRODUCT ENGINEERING

second annual MASTER DESIGN AWARDS

for Achievement in Product Development

Judging a contest is an honor, true, but it is also a tremendous responsibility. And we editors of PRODUCT ENGINEERING have been extremely fortunate these past two years in having judges for our Master Design Awards who did not take their responsibilities lightly. In each judging, the panel has been extremely conscientious in its selections, eventually choosing only those entries which meet a most exacting standard.

The seven judges this year, from the Detroit area, were, like most competent men, extremely busy, so they could not meet until April 19. Each had, however, been provided with copies of the almost 100 entries in advance and "had done his homework" before the meeting, thus only five ballots and a final elimination were necessary.

Some 91 entries were ultimately approved for the balloting, ranging from elaborate and complex computers to simple tools, a camp lantern, a set of luggage. The judging was done on the basis of the criteria of good design, expressed by one judge as: functionability, produceability, salability, and cost. In the judging group were two engineers, two industrial designers, two college professors (one of design and one of engineering) and a management consultant, so the skills represented were broad and diverse.

The first ballot eliminated 32 entries—principally those that were primarily style changes, application of familiar engineering principles, or conspicuously lacking in integration of design and engineering factors. The second ballot (just after lunch) removed 19 more, leaving 40 entries. Again, the basic criteria were applied.

The third ballot removed 18, including some that met the basic criteria but didn't measure up to the others. Among them: "Design good enough for an industrial product, but not outstanding." "Not really integrated." "Excellent engineering, but 'package' design faulty." "Weight too high for function." "Too gadgety." "The latest step in a long-term project; not sufficiently outstanding." "Insufficient visibility in dials." "Missed opportunity for exceptional packaging." "Package good, but does not allow for all safety factors." "Styling over-emphasized." "Basically a modification of familiar designs." "Just a change of materials—sound enough but not resulting in a major advance."

Thus 22 designs entered the fourth round. Now the eliminations were slower, the discussions more prolonged. The four editors present (Tangerman, Kolb, Kelleher, Giordano) were occasionally called upon for a point of information. At one point, the photographer, who is also a competent metallurgist, offered a piece of information. But it was always the judges who decided, flatly and finally, as judges do. They debated the appearance of one design, the weight of another. In most cases, an approving or dissenting group within the panel was not made up of men from the same discipline, as might be expected. Engineers commented on appearance, designers on engineering, and vice versa. There was comment about appearance to suit function and cost to suit appearance or engineering. But eight more entries were removed.

Then came a further review of all remaining entries—those that had won the votes of at least four judges. The panel decided by formal vote that this was not good enough—that at least five judges must agree. Further discussion, entry by entry, until the room grew dark, and at last the list was cut to the final nine which the judges agreed were most representative, truly master designs. Then they took an unprecedented further step: They singled out Entry 54—The WARD Planisphere—for special commendation in that it represented the results of outstanding work in collaboration among engineer, designer and a surgeon to meet a pressing need of humanity.

Now turn the page for details on the 9 winners.

PANEL OF JUDGES

Left to right (standing)

KURT O. TECH
Vice-president—Engineering
The Cross Co

AARRE K. LAHTI
Professor of Design
University of Michigan

STANLEY M. HUMPHREY
Partner
Booz, Allen & Hamilton

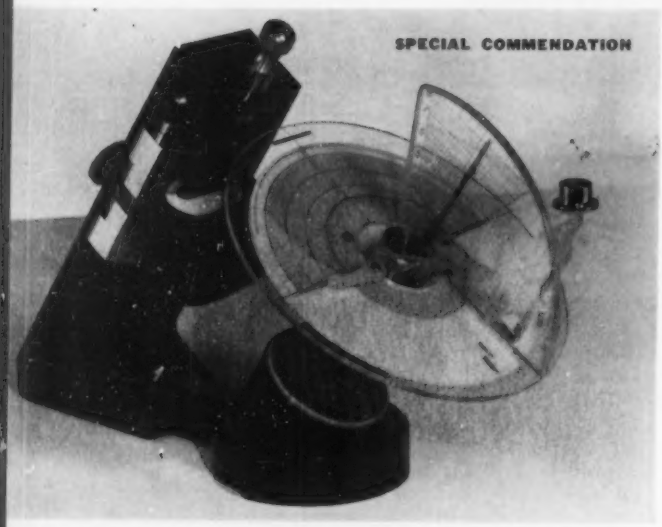
FRANK S. REAUME
Research & Engineering Center
Product Engineering
Ford Motor Co

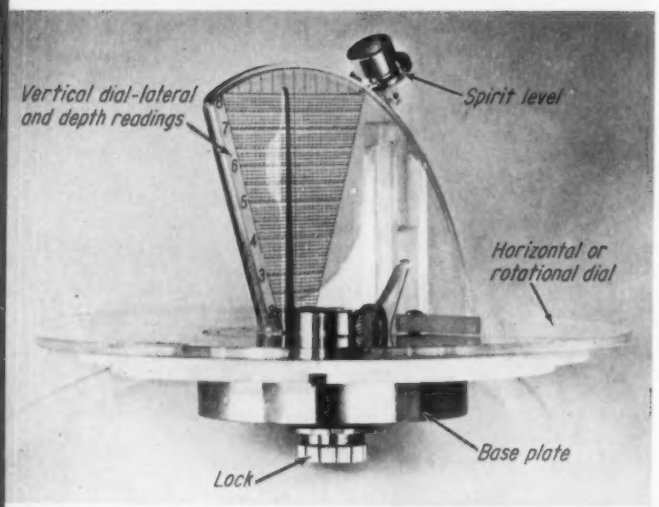
(seated)

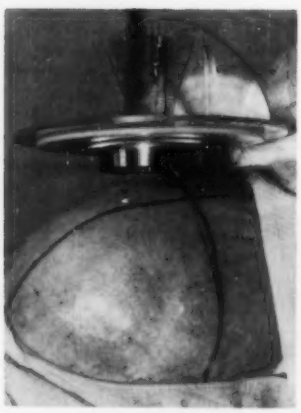
MONTGOMERY FERAR
Partner
Sundberg-Ferar

J. M. LITTLE
J M Little Associates

GLEN H. HOWELL
Professor of Mechanical
& Industrial Engineering
Wayne State University







MASTER DESIGN CERTIFICATE WINNERS:
Jack Stern, MD, University of Washington Medical School
William Knox Jr, medical engineer
Arthur A. Ward Jr, MD, University of Washington Medical School

Knox Instruments Inc
Seattle, Washington

Ward planisphere . . .

provides the physical means of triangulation by which the center of the area affected by Parkinson's disease within the brain may be located, preparatory to surgery. Its function during such surgical operations is to locate precisely a predetermined point within a 6-cm diameter at any depth from 2 to 8 cm, utilizing controlled movement in three directions.

Parkinson's disease attacks the brain from within and spreads spherically outward, destroying brain tissue in its path. In most cases, the area first affected is a point at eye level and back between the ears. Theoretically this location is in the center of the head.

To destroy the disease, the tip of a hollow stylet must be located directly in the center of the diseased matter. Fluid is injected through this stylet and absorbed spherically by the diseased tissue. If the tip is located accurately, the fluid destroys the diseased tissue with no injury to any other portion of brain.

A surgical problem therefore existed: How to transfer mathematical calculations to physical and visual location of the exact core of diseased tissue within the center of the brain. A system of triangulation and coordination was indicated, involving motion and measurement in three planes—lateral, horizontal and vertical.

The design was based on certain surgical requirements:

1. The instrument must operate through a ¾-in. hole in the skull.
2. It must attach to the head in some fixed manner.
3. It must be lightweight and easily sterilized.
4. It must contain the visual and physical means of locating any given point within a definite area.
5. It must be fabricated of a material which would allow the clear passage of an X-ray beam.
6. The through factors in the correlation of X-rays dictated that a means must be provided to establish an equal plane between the patient's head, the instrument and the portable X-ray machine.
7. It must locate the point desired within 0.25 cm.

A tapered stationary lock designed to be tapped lightly into a ¾-in.-dia hole in the skull provides a means of attaching the instrument to the head. As it is tapped in, the vertical teeth of the lock cut ridges into the bone structure, thereby providing a gripping action preventing rotation when the steel base is screwed into the lock. As the stainless-steel base plate is screwed into the stationary lock, the lock expands and bites the skull structure firmly. These two parts then provide a firm base for the instrument's vertical and horizontal dials.

The Plexiglas horizontal dial has circles silk-screened in millimeter graduations, representing distance from the fulcrum point in a horizontal plane. Onto these circles are marked increments representing distance to the left and to the right of the center reference line. To the underside of the dial a diametral spacer is added containing three magnets. These magnets in turn grip the edge of the base plate when the Plexiglas dial is affixed. The center line on this dial is then rotated around until it agrees with one of the reference lines on the skull. Next, the top hub-section containing the fulcrum axis and motion locks is inserted. Attached to the top of this nylon section is a clear horizontal dial with a vertical dial bonded to it.

The vertical dial provides lateral and depth readings. The clear horizontal dial provides rotational centerline movement. The "opaque" horizontal dial provides rotational readings from the fulcrum centerline. The patient's hair and incision are screened by the opaque dial, thus eliminating any distraction to the operator. The instrument, when in place, provides a visual and physical means of triangulation for standard X-ray equipment.

In more than 300 surgical operations the desired point has been located within 1 mm.

Automatic slide projector . . .

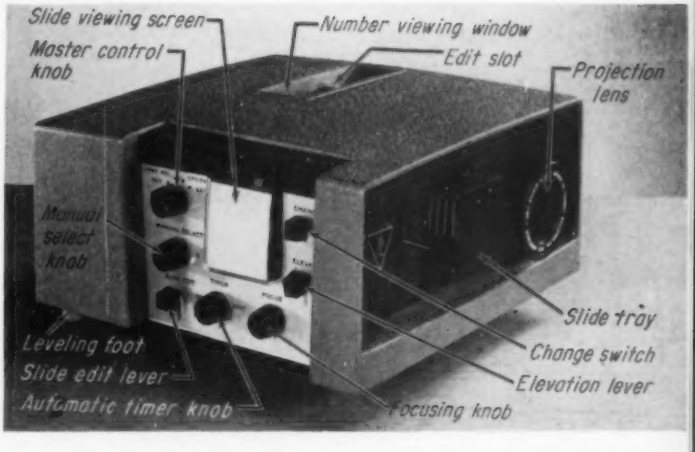
was designed to replace the existing top model in this manufacturer's line and to reflect the trend to more automatic operation in this field. Engineering and design requirements were established by the development staff by assembling and evaluating information from market experience with current Bausch & Lomb projectors.

Two major changes were made in the new projector after development was well advanced. One was an editing arrangement—a slot and a lifting lever that raised incorrectly inserted slides so that they could be reinserted without removing the magazine from the projector. The other change was the addition of remotely controlled, powered reversal.

Addition of the editing feature required vertical movement of slides up through a slot as well as horizontally. It soon became evident that air pressure from the lamp cooling fan was sufficient to hold the slide firmly in place, so it was possible to eliminate holding springs. This resulted in practically no wear on the slides and exceptional freedom from jamming.

The powered reversing system is actuated by a dot-dash signal from the remote-control switch. A forward slide-change cycle is initiated by depressing the control button for 0.10 to 0.35 sec, a reverse cycle by depressing for 0.35 sec or longer.

Ducting and baffling developed to conduct cooling air over the projection lamp and through the magazine holding the slides required considerable testing and experimentation with air temperature and flow rates. A flow of air heated to an adequate temperature to "pre-pop" the film for consistent focus was finally assured at all operating line voltages (110 to 125 v).



MASTER DESIGN CERTIFICATE WINNERS:
J. A. Clark, director of mechanical engineering
J. R. Benford, director of visual instruments R & D
H. J. Emmel, project mechanical engineer
M. Krajowsky, design mechanical engineer
E. L. Turner, consumer products, chief engineer
C. H. Brumley, director of electronics and measuring instruments R & D
C. Shute, electrical engineer
K. Maier, industrial designer
Henry Dreyfuss, industrial design consultant

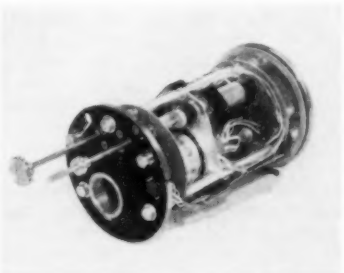
Bausch & Lomb Inc
Rochester, New York

Industrial television camera . . .

was developed specifically to fill the need for a unit capable of surviving the most severe industrial and military environments. Preliminary mechanical analysis indicated the advantages of a tubular housing, with all components mounted on an internal structure independent of the housing itself.

The principal design problem centered around protection of the fragile vidicon picture tube from shock and vibration. Resilient mounting was not permissible because relative movement between the tube and its deflection coils, or between the tube and its lens, would cause modulation of the televised picture. Another problem was resonant vibration of the circuit boards on their mounting structure. At resonance, transistors, capacitors and other components virtually jumped off the boards. Sealing of the case, mounting of the interior assembly inside the tubular housing, and the mount for the entire camera were among the other problems encountered.

A heavy-wall tube was selected for the housing—heavy enough to isolate the structure from audio noise, to permit a relatively simple threaded bezel ring, an O-ring sealing system, and to resist explosion and immersion pressures. No screws or attachments penetrate the tube's walls. The lens end



of the assembly is supported by a disk having two segments that can be expanded against interior tube walls by inserting a pair of tapered pipe plugs. The rear end of the assembly is attached to the rear closure and retained by a second bezel ring identical with the one that holds faceplate.

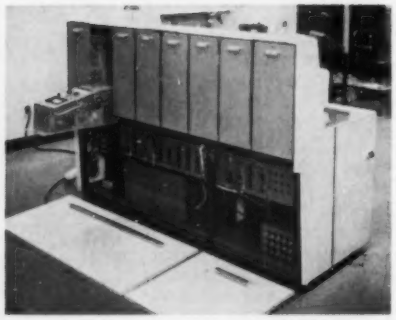
Resonant effects on the circuit boards are minimized by triangular stud-and-spacer mountings. These are rigid but have considerably more damping effect than conventional arrangements.

The vidicon tube is rigidly mounted inside its deflection coils, which are epoxy-encapsulated into a solid mass.

All major parts of the camera, except for the extruded tube and the diecast mount, are zinc diecastings.

MASTER DESIGN CERTIFICATE WINNERS:
W. S. Ivans Jr, v-p, Engineering
Joseph Petit, project engineer, television
Richard Hiatt, electronics engineer, television
Walter Wind, chief mechanical engineer
Herb Gill, senior mechanical engineer
George Churcher, layout draftsman
William Davis, industrial design

KIN TEL Div, Cohu Electronics Inc
San Diego, Calif



Rear view of mass spectrometer showing one of the electronic chassis in tilt-down servicing position. Lower cabinet's panels have also been removed. Adjustments rarely required can be made from the front of instrument by lifting hinged top of console.

Laboratory mass spectrometer . . .

for the quantitative and qualitative analysis of gases, gaseous mixtures and vapors was based on the following parameters: Selling price was to be around $35,000, depending on customer specifications—this compares with a price of $55,000 for larger instruments of this type. The new spectrometer was to be applicable to all types of analytical laboratories: petroleum plants, universities, medical institutions, research organizations.

In addition, the project engineer suggested development of an instrument that would: 1) have its electronics unitized by function with maximum accessibility; 2) use a direct-writing oscillograph that would display finished data for analysis while scanning of gaseous samples was still in progress; 3) have a configuration suitable for somewhat restricted quarters and be of minimum over-all weight.

As a means of achieving these goals, the industrial designer recommended a cabinet construction consisting of a new Formica-over-honeycomb sandwich panel he had developed with instrumentation mounted on welded aluminum frames.

A new tilt-down chassis concept for each electronic module was also worked out, in place of the classic sliding drawer common to most electronic equipment. Each module was to have its own integral instrument and control panel and wiring to permit maintenance, trouble shooting and repair while the spectrometer was in operation.

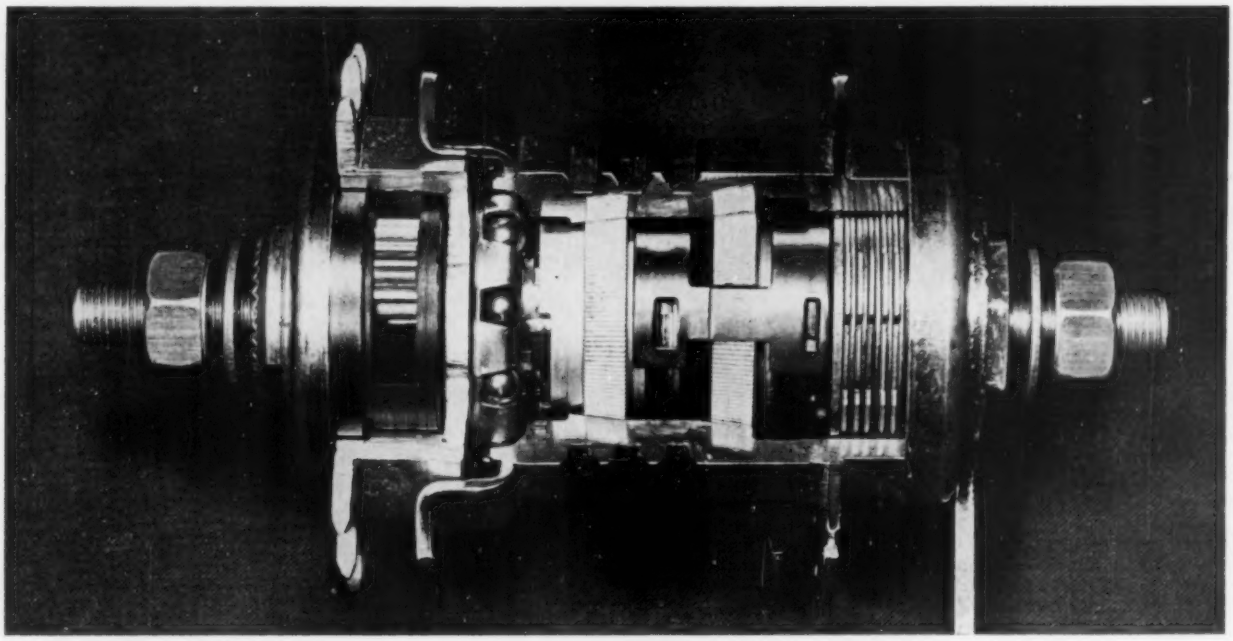
Inclusion of a number of blank tilt-down chassis to allow for future expansion of the instrument was agreed on. For optimum installation flexibility, the instrument was to be housed in two separate cabinets, one for the electronics and one for the analyzer.

Once the general configuration and appearance was set, all elements of the design were reviewed to insure adherence to good human engineering practice. This helped to shorten operator training time and insure optimum operation with minimum fatigue and error.

At the suggestion of the mechanical engineer associated with the project, a solid manifold block with six integral valves was used to eliminate the excessive plumbing, soldered joints and fixtures, with their associated problems of leakage and high cost, that generally characterize analysis equipment of this type. A newly developed, tin-plated copper gasket of the shear type was also used. This assured an all-metal vacuum system that eliminated the outgassing which can contaminate samples being analyzed. The new gasket also made possible heating and cooling cycles in the manifold block without developing leakage at the joints.

MASTER DESIGN CERTIFICATE WINNERS:
Charles G. Blanchard, project engineer
Andrew Nowina-Sapinski, senior industrial designer
James B. Henderson, associate engineer

Consolidated Electrodynamics Corp
Pasadena, Calif



Automatic transmission and brake for bicycles . . .

is an entirely self-contained unit (shown actual size) developed to compete in price and performance with both foreign and domestic cable-operated devices. These transmissions have epicyclic gearing, which usually requires shifting one of the gear members from a locked gear-train position that turns at sprocket speed to a gear reduction or overdrive position. One of the design objectives for the new integral transmission was to eliminate shifting of one gear-train member.

The basic mechanism provides two speeds and uses an epicyclic gear train, coupled with two threaded screws, made so that one rotates inside the other. Mounted on these screws are driving nuts, which when retarded, or prevented from rotating, traverse along the screws. The outside screw turns at rear sprocket speed. The inside screw, because of the gear reduction, turns at two-thirds sprocket speed.

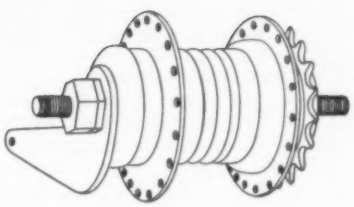
Therefore, when forward driving takes place, the higher-speed nut will always drive the hub unless means are provided to block engagement. This is accomplished by a backpedaling cycle of about 2 in., causing a selector mechanism to block the high-speed nut on alternate cycles. This permits the low-speed nut to engage the hub, driving it through the associated gearing at approximately two-thirds the rear sprocket speed. A second backpedaling returns the transmission to high-speed operation.

Because the low-speed driving nut is also the member that compresses the brake disk pack when the operator backpedals to braking position, the low gear ratio allows greater force to be applied, producing a power-braking effect. The disk type of brake was selected because of space limitations, and it was necessary to do considerable testing to develop the proper combination of brass and steel for the disks which cannot be sealed off from grease in adjacent components.

Two major design difficulties were overcome. One was the tendency of the unit to lock when the high-speed nut was engaged and the bicycle rolled backwards. Because of the epicyclic gear train, this caused the low-speed nut to travel in the braking direction, applying the brake. An anti-locking mechanism was developed that restricts the travel of this nut when the high-speed nut is engaged.

But the single biggest problem was the retarders which cause longitudinal travel of the nuts. Retarders used in previous coaster brakes were found to have a considerable difference in torque between their breakaway and running values. It was necessary to have the low-speed retarder exert a greater drag than the high-speed retarder. Two-way clutches of a wrap-around spring type were developed. Because both retarders must slip in two directions, a coupling was made that, with a small amount of lost motion, will tend to unwind the wrap-around spring in either direction, producing the required torque value.

Model-shop assemblies of the new brake were installed in newsboys' bi-



cycles in the vicinity of the plant. These were checked, revised and necessary components changed as actual service proved them out. An endurance machine was also employed, to test individual parts.

Originally, hydrogen brazing was used freely to produce components from the smallest possible sizes of bar stock or tubing. However, in the course of development, cost studies showed that some assemblies could be made at less cost by machining entirely from bar stock.

MASTER DESIGN CERTIFICATE WINNERS:

Nelson H. Mageoch, assistant general manager, management
Joseph W. Poliseo, manager of engineering, administration
Frank T. Christian, chief engineer, supervision
E. Elliott Hood, product engineer, design
Hollis K. Gleasman, test engineer, testing

Eclipse Machine Div
The Bendix Corp
Elmira, New York

All-transistor TV receiver . . .

was developed as a result of a 1957 directive from top management to design a portable TV large enough for family viewing either indoors or out and which could be operated from an internal power source as well as a standard power line. Although such requirements clearly pointed to transistors, no semiconductors available at the time possessed the necessary high-frequency characteristics or power-handling capabilities. Cathode-ray tubes requiring only a fraction of the normal scanning power were also needed.

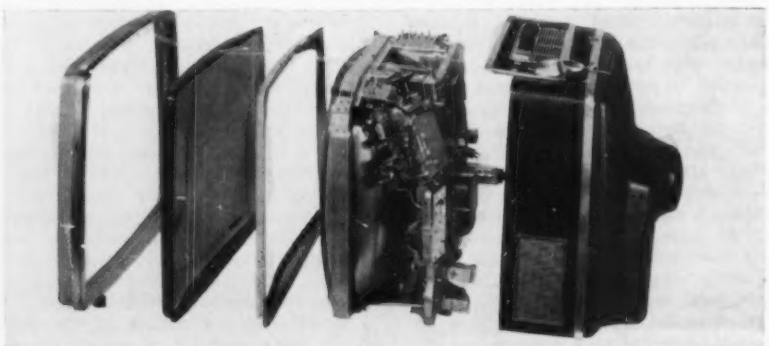
A magnetic lens capable of reducing scanning power 9:1 was developed first. Then, in Jan, 1958, an operating prototype of an all-transistor TV with a 14-in. tube (90° deflection angle) was presented, but subsequent market research indicated that a larger screen was necessary as well as a configuration more like that of modern luggage.

The present set has a 19-in. tube, with a 114° deflection angle. Housed in a vinyl-covered, glass-reinforced polyester luggage case, the chassis and all internal metal parts are aluminum. The receiver weighs 40 lb, complete with its rechargeable silver cadmium battery (capable of delivering 1.4 amp at 18 v for 4 hr throughout a 2-yr service life). A latched cover of the same material as the housing covers the picture tube during travel or storage.

MASTER DESIGN CERTIFICATE WINNERS:

H. N. Frihart, chief engineer, Advance Dev. & Res. Dept
J. Sciurba, senior electrical engineer, Tuner Dev
D. Taylor, senior electrical engineer, scan magnifier
D. Griffey, senior electrical engineer, IF Dev
G. Cecchin, electrical engineer, deflection-hi voltage
O. Thurnell, mechanical engineer, mechanical design
L. J. Mattingly, section head, TV Special Products
A. W. Massman, chief electrical engineer
J. Caprio, electrical project engineer, IF design
R. Yoder, electrical project engineer, tuner design
D. Dedinas, electrical engineer, IF design
R. C. Voige, electrical engineer, vertical & AGC design
M. F. Buechel, electrical engineer, high voltage & sync
R. L. Frank, electrical engineer, battery evaluation
E. Statsny, chief mechanical engineer
R. Calderon, detail draftsman
D. Reinerston, layout draftsman
R. Krolopp, industrial designer

Motorola Inc
Franklin Park, Ill



¼-in. Electric drill . . .

which the engineering group was asked to design had to have exclusive sales features, function better than competitive products, look totally different and still be manufactured at a profit.

The engineering group first listed the basic disadvantages of present drills. None permitted the operator a full four-finger hold on the tool unless he grasped the hot motor. Also, the part of the hand best suited for directing the drill was not in line with the drill bit, resulting in lack of control with small-diameter bits. The most powerful drills either ran at high speed or required double-reduction gearing to hold spindle speed at 1800 rpm, the most efficient speed for a ¼-in. drill.

Placing the motor at right angles to the spindle provided shortest distance from the hand to the bit, gave better one-hand control, and allowed the drill to be used in tighter quarters. It also assured a completely different appearance.

But this posed a problem with gearing. For high power, the motor must run at high speeds—this same engineering group had designed a successful sabre saw with a motor speed of 28,000 to 30,000 rpm. The same speed in a drill would require a gear reduction of 16:1. Single-reduction spur or helical gearing used in ordinary drills with low-speed motors could not provide a ratio of more than 8:1 and still keep gear diameter within size limitations. Double-reduction gears could increase the reduction to about 10.5:1 but at prohibitive cost. Bevel gearing would be noisy and, because of line-to-line contact, the gear tooth would have to be quite large, increasing cost. Hypoid gearing would reduce the noise but increase the cost. Worm gearing appeared to be the best conventional answer but cost and low efficiencies ruled it out.

Patented Spiroid gearing provided the answer. A ratio of 15:1 could be obtained easily. The pinion could be rolled directly on the motor's armature shaft (made of leaded SAE 8620, cyanided). The gear was made of pressed and sintered steel powder, approximately 95% iron, 4% copper, 1% carbon, hardened after sintering.

Lifetesting of several high-speed motors proved that they could not take the current drain that developed at 28,000-30,000 rpm. And although some of these motors could be rated at up to 4.5 amp (a continuous rating of 3 amp had been planned), after 5 hr operation at rated load the commutator would throw a bar or the winding insulation would break down. At such high speeds, difficulty was also experienced with the sintered gears. They wore down short of the desired number of hours.

Reducing the speed of the motor to 24,000 rpm and lowering gear ratio to 12⅔:1 solved both problems and kept cost down. Initial fears that the sintered gears would not withstand shock loading were dispelled after some special tests were run. Using a hedge trimmer attachment and with the unit running at high speed, a steel bar was jammed into the hedge trimmer teeth. No damage to the teeth occurred.

As the sabre saw mentioned previously had a pedestal base (which facilitated blade changing), it was decided to try this on the drill. This made the drill more convenient to use and also minimized accidental drill bit breakage. The position of the motor-cooling fan just below and in back of the chuck invited its use as a sawdust blower, and the industrial designers incorporated a simple slide valve in the housing that made it possible to shut off the air stream when desired.

MASTER DESIGN CERTIFICATE WINNERS:

James M. Katzfey, chief engineer, Consumer Products
Don J. Hutt, design engineer
John C. Ion, project engineer
Robert Russell, design engineer
James Parcher, industrial designer
Sam Leotta, industrial designer

H. K. Porter Company Inc
Disston Div
Philadelphia, Penna

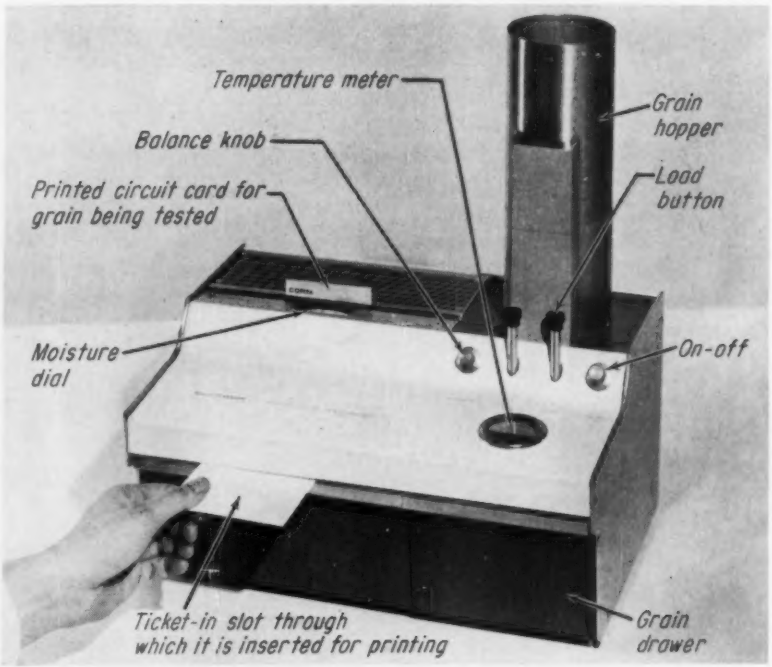
Moisture recorder . . .

is an electronic instrument for the use of grain-elevator operators in testing moisture content of wheat, barley, rye, corn and other grains. Besides providing a visual dial reading, the recorder also contains an electronic printing device that records moisture content on paper.

Former moisture testing equipment required approximately 1 minute to test a grain sample; this device does it in 5 sec, without computations. Speed is attributable to the automatic correction for temperature of each grain sample by thermistor and to the servo-controlled RF capacitance bridge system, in which the grain sample forms one leg of the bridge and a variable capacitor is rotated by motor to balance the bridge. The resulting reading of the capacitor is then interpreted in terms of moisture content.

In order to provide a linear readout, which would read correctly in moisture for all grains, the curve of capacitance vs rotation is automatically shaped by affixing to the servo system shaft specially shaped rotor blades which engage printed-circuit stators. These stators are actually plug-in cards, one for each grain type to be tested. By inserting a card in the appropriate slot in the recorder, the moisture tester is automatically programmed for any kind of sample. Printed circuit cards for any six types of grains are supplied with recorder.

The traditional moisture tester was a dark metal box with a bewildering array of dials, controls and protuberances, so consultant designers for the Burrows recorder felt that a clean, uncluttered look would suggest the instrument's most important characteristic: ease of use.



MASTER DESIGN CERTIFICATE WINNERS:

George H. Fathauer, president, Radson Engineering Corp
David Fathauer, Radson, project engineer for mechanical development
Parke W. Burrows, president, Burrows Equipment Co
John W. Wastcoat, vice pres and general manager, Burrows
Theodore Prisland, industrial design, Latham-Tyler-Jensen
John Benty, industrial design, Latham-Tyler-Jensen

Radson Engineering Corp
Macon, Ill

Compact electric typewriter . . .

is fully powered and designed to be used without further training by anyone familiar with the operation of standard manual machines, with which it is comparable in price. Machine is compact enough and light enough to be moved around easily and used where space is limited. Because electrical typing requires only touch actuation instead of physical or muscular pressure on the keys, basic shape of the keyboard was changed, with keys arranged in upward curves at either side to fit more exactly the shorter fourth and fifth fingers. Keyboard shape was reduced to position more nearly parallel to lower arm in typing position. To concentrate control of the machine's functions in the keyboard area, ribbon control, type-bar style face and automatic repeat buttons are all adjacent to other key buttons.

Automatic carriage return and linespacing is based on a rack-and-pinion mechanism. The relative simplicity and low-cost characteristics of this design—as compared to the mechanisms in manual machines—is a large part of the reason for the new typewriter's advantageous price position.

Deck cover, which is an aluminum diecasting soundproofed on the under side, slides forward to provide access for ribbon change, type cleaning, guide adjustment. Base and frame are also aluminum diecastings. Perforations, louvering and high heat-transfer rate of aluminum maintain the temperature required for optimum machine function.

MASTER DESIGN CERTIFICATE WINNERS:

E. G. Moshier, vice-president, Engineering
A. C. Zeamer, manager, Production Engineering
J. Barkdoll, chief project engineer
R. Metzner, staff designer, Industrial Design dept
D. O. Chase, consultant industrial designer
P. H. Stevens, consultant industrial designer

Smith-Corona Marchant, Inc
New York City

NOW... Pre-shaped Epoxy Adhesives

Like preforms for soldering and brazing, these adhesive pellets contain just the right amount of joining agent—shaped to fit the joint.

VINCENT SUSSMAN, *v-p, Engineering*
Epoxy Products Inc
Irvington, NJ

Epoxy adhesives suffer from three limitations when applied to mass-production assembly of small parts. As liquids or pastes they are: (1) hard to manipulate, (2) difficult to meter, (3) irritating to the skin.

When you put them into a meltable solid form, however, the limitations are overcome–and the resulting pellets introduce several related advantages:

- As a pellet, the pre-shaped adhesive can be placed exactly where it's needed in the assembly, and in the right amount. Post-cleaning is unnecessary.
- It can be preformed to fit into the assembly like any other part, thus becoming suitable for automatic assembly lines.
- It will join metal inserts to plastic molded parts, thereby sidestepping expensive tooling for positioning these inserts during the molding process.
- Different types of adhesive can be easily included in the same assembly. For example, at one point a high-strength adhesive may be required; at another point, the adhesive may have to conduct electricity.

There are two inherent disadvantages to adhesives in this solid form, however, and they require remedial measures:

- The pellets are not tacky, so the adhesive in this form cannot be used–as can tacky liquids or pastes–to hold parts in position until the adhesive hardens. This requires self-aligning designs or external fixtures.
- Inserts bonded into deep holes tend to "float" out of position as the pre-shaped adhesive melts. This can be corrected by shaping the pellet as a tube around the insert, or by using a fixture for positive positioning.

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Pre-shaped Adhesives

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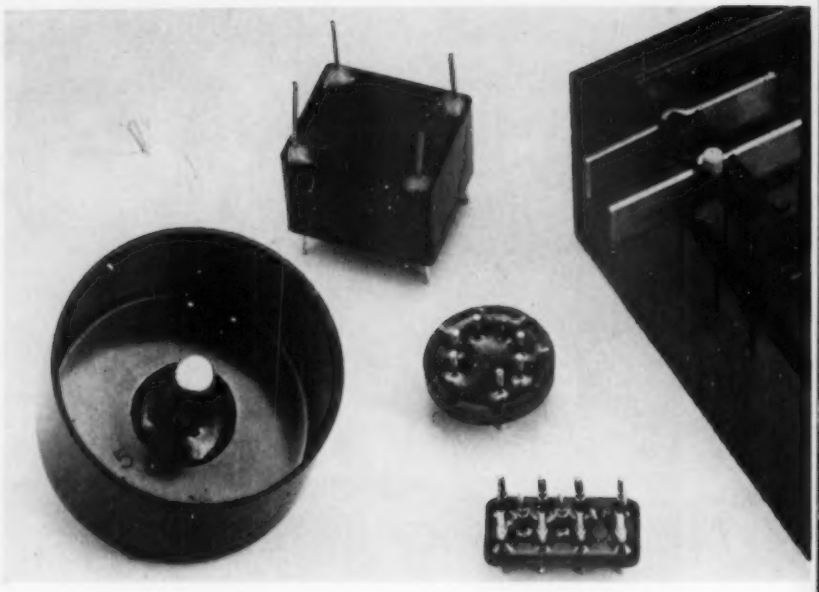


METAL INSERTS are mounted with pre-shaped adhesives in these five plastic parts—no need for in-place molding that would require expensive jigs. Electrical connector box at right shows one blade already bonded in place; second blade with adhesive pellet in place ready for bonding (in actual production, pellet drops all the way into the hole). For knurled metal insert in left-most part, adhesive was pre-shaped into a ring, giving appearance of a weld fillet.

Specifying pre-shaped adhesives

As with conventional epoxy adhesives, pellets can be formulated to meet a wide variety of requirements—one of which usually dominates a given application. Here are the factors you should consider when designing for pre-shaped epoxy adhesives. Some are common to liquid and paste epoxy adhesive systems, others are peculiar to pellets. Close attention to them will improve your designs:

1. Materials to be bonded. Metals, glass, plastics and ceramics can be bonded to themselves or to each other by varying the resin and curing agent to fit the basic material combination. For metal-to-metal bonding, precleaning the surfaces is a must. The accompanying table lists some typical metals, with their recommended chemical cleaning solutions. Epoxy pellets are 100%-solid systems. This means all the adhesive is used; unlike soldering or brazing, they leave no corrosive flux to clean away or gas to be driven off.

2. Temperature and time of cure. Pellets will set up quickly at high temperatures, slowly at lower temperatures: A typical bonding pellet that cures in 4 min. at 250 needs 24 hr to cure at 85 C. Min curing temperature is 85 C. Thus, the heat sensitivity of the parts being bonded must be known so that the right pellet or cure cycle can be selected.

Heat application method is important too. Oven or hot plate methods require pellets with good thermal conductivity. But this is not a problem with induction or dielectric heating.

Pellet adhesives will retain their properties significantly at operating temperatures up to about 150 C, a definite limitation compared to soldered or brazed joints.

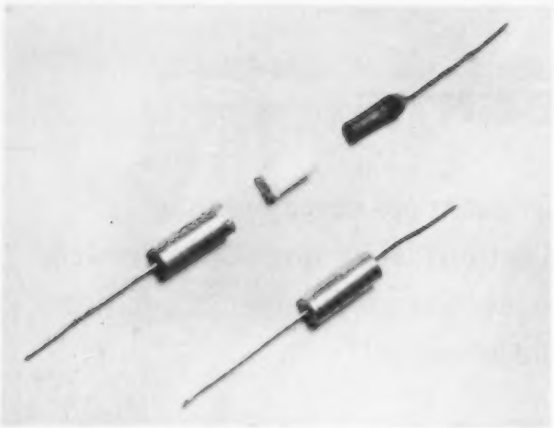
3. Adhesive flow. The pellet, when melted, must be able to flow where needed, but no farther. Pellet viscosity can be widely varied. When clearances are loose, therefore, a high-viscosity adhesive will be chosen; when the fit-up of the part is tight, an easier flowing adhesive is the answer.

4. Pellet dimensions. Except for those designed to flow into tight fits (1-3 mils clearance) in structural joints, most pellets are contained by the parts and retain their shape and dimension after curing. Consequently, pellet dimensions are usually roughly those of the cavity that will be filled with adhesive. With present pre-shaping equipment, minimum pellet OD is 0.050 in. and minimum wall thickness is 0.040 in. Larger pellet dimensions present no problem, though maximum size so far is 1 in. OD.

5. Bond properties. Bond strength is high, 4700 psi in shear for steel-to-steel joints; for most other materials, the basis material tears before the bond gives. Best bond strengths come from pellet compositions that cure at 150 C or above. Finished bonds can be made with either high or low thermal-expansion coefficient (from 10.0 x 10^{-5} to 2.0 x 10^{-5} in./in./°C). When temperature cycling is a problem, the epoxy can be made flexible to take up thermal strains.

RECOMMENDED METAL CLEANING SOLUTIONS

Metal	Surface Treatment (parts by weight)	
Aluminum	Sodium dichromate	7
	Sulfuric acid (conc.)	1
	Water	17
Copper Brass	Ferric chloride (42% soln.)	15
	Nitric acid (conc.)	30
	Water	197
Cadmium, plated	Chromic acid	60
	Sulfuric acid (conc.)	1
	Water	400
Stainless Steel Steel, bare	Sulfuric acid (conc.)	37
	Water	90



TANTALUM CAPACITOR—bonded assembly, foreground, resulted from fitting the tantalum slug into tubular adhesive pellet, slipping them into the can, and heating. Pellet contains silver to create electrically conductive bond between tantalum (one terminal) and can (the other). Unlike solder, pre-shaped adhesive avoids damaging the heat-sensitive slug.

Addition of silver powder makes pre-shaped adhesives conductive over a wide range (0.0005 ohm-cm to 0.1 ohm-cm); conductive pellets cure at low temperatures, making them suitable for heat-sensitive assemblies. Other performance characteristics (common to all expoxy adhesives): good chemical and solvent resistance, low moisture permeability, and good electrical characteristics at both high and low temperatures.

EDITOR'S NOTE: Other, recent articles that cover the use of epoxy resins in engineered products include:

Epoxy Parts Cast by Centrifugal Force, May 23 '60, p 45—A simple, low-budget method for producing precision plastic parts in quantities that don't justify the high tooling cost of injection molding.

Speed Your New Product with Cast Epoxy Models, Dec 21 '59, p 60—How to convert new-product ideas quickly and directly into actual parts or assemblies, allowing simultaneous appraisal of many designs.

Three-dimensional Photoelasticity, July '57, p 135—How to use epoxy casting resins as the key to more effective use of a powerful stress-analysis tool.

The following recent articles concern epoxies as adhesives or encapsulants:

A Survey of Encapsulating Systems, Sep 19 '60, p 68—The technology of encapsulation is now so broad that you may not know where to start. This article introduces the subject and compares the basic systems.

Stresses in Adhesive Joints, July 7 '58, p 64—Author analyzes the six basic joint designs and shows how to calculate stress concentrations in each.

Sandwich Panel Adhesives, May 26 '58, p 56—Concluding part of 3-part series on sandwich panel materials describes and compares the 14 most widely specified adhesives.

When adhesives won't do the joining because of excessive loads or temperatures, check these articles for guidance:

How to Choose the Right Soft Solder Alloy, Mar 6 '61, p 39—Author of previous article (June 13 '60) on fluxes focuses on the solders themselves, compares 28 basic types.

Welding or Brazing Dissimilar Metals, Dec 19 '60, p 46—Author gives three ways to achieve joints with no leakage at high pressure, and presents the design data you need.

Designing Brazed Joints for 1000 F and Above, Aug 1 '60, p 40—High-temperature brazing efficiently joins stainless steels, alloy steels and the superalloys. This roundup tells how it works, when to specify it, how to select the right materials, and procedure for starting the design.

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how to select

THREADED INSERTS

Why use a threaded insert? What types are available? What factors govern their selection? How do you determine whether a particular insert meets the given strength requirements, and which one is most economical?

S H DAVISON, *Flight Propulsion Div, General Electric Co, Evendale, Ohio*

When the design calls for lightweight materials like aluminum, magnesium and plastics, threaded holes become a problem because of the low shear strength of these materials. To bolt such components to other machine parts, the threaded holes must be quite deep to develop the required pull-out strength, or they must have a coarse thread to increase shear area.

Further complications arise when the components require frequent disassembly for overhaul or repair; this may give excessive thread wear that will prevent satisfactory thread engagement with the bolt, particularly for high-strength bolts in the fine-thread series; and the depth of engagement needed will require a part so thick as to nullify the lightweight advantage of the material. To overcome these problems, thread inserts of high-strength material are often used.

Inserts available

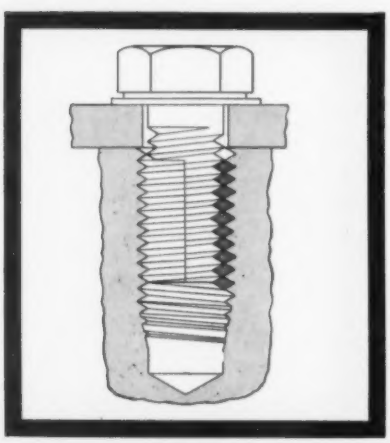
Three main types of inserts are available:

1. Wire thread inserts are precision coils of diamond-shape stainless steel wire. They line a tapped hole and present a strong, accurate, standard internal thread for the bolt or stud. The OD on these inserts is from 11 to 30% greater than the OD of the internal thread—the lower limit is normally used on the fine-thread inserts specified in aircraft engines. The pull-out strength of wire thread insert depends on shear area of its OD thread.

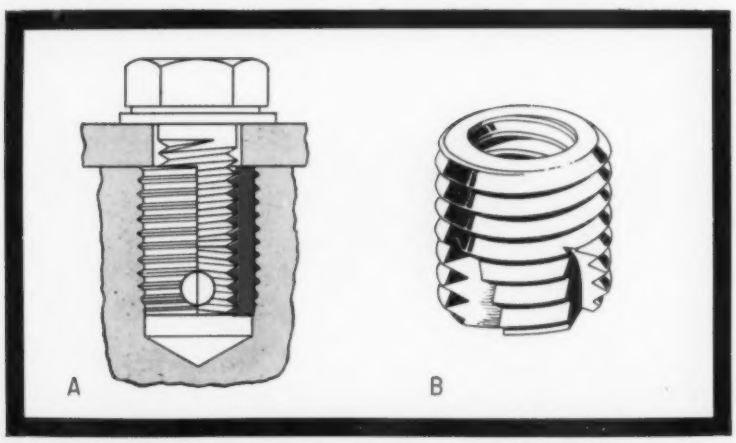
2. Solid self-tapping inserts require only a drilled hole and counterbore in the part, and are made in two basic forms. (1) A solid self-tapping, self-locking bushing has a 60% external thread approximating the American National form with a uniform OD extending to the first 2 to 2½ threads. These leading threads are slightly truncated to provide the cutting action necessary for self-tapping. Chips flow out through the side hole drilled in the insert wall at the truncated lead threads. (2) A second type has lead threads similar to the pilot threads of a standard tap. These threads progressively flow into truncated threads extending the entire length of the insert—with the exception of the last three threads, which are standard.

In both types, two or three angular slots, depending on the particular design, provide the cutting action for self-tapping.

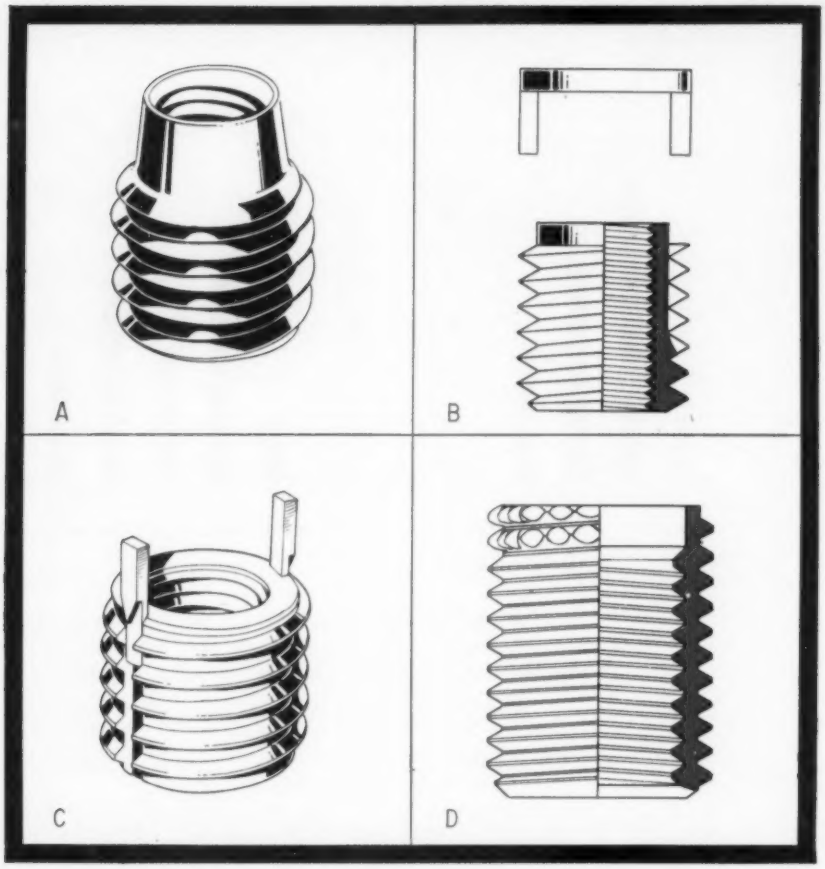
3. Solid bushings for pre-tapped holes are also made in



WIRE THREAD INSERTS made of diamond-shape stainless steel wire. Pull-out strength of material depends on ratio of internal to external thread shear area.



SOLID SELF-TAPPING INSERTS are of two types—(A) chips are removed through the side hole; or (B) with truncated lead threads and two or three angular slots which provide cutting action.



SOLID INSERTS FOR PRE-TAPPED HOLES have many variations. Among the most popular are: (A) modified external threads for interference and locking action; (B) two-piece unit with key ring for locking action; (C) integral keys give locking action; (D) expandable collar with external serrations.

two general types. The first uses modified external threads that form an interference with the parent material, and provide locking action. The second type has many variations, but is characterized by standard external and internal threads, with various types of pins or keys to lock the bushing to the parent material. Some of the most widely used variations are:

A two-piece insert with a locking ring and two keys fits into mating grooves in upper external threads. The ring is pressed into place after the insert is screwed into tapped hole; it cuts through enough threads of parent material to provide a positive lock. A counterbore in the tapped hole is required for the ring, but assembly and replacement can be made with standard tools.

Another solid bushing insert has two integral keys which act as a broaching tool when insert is installed flush with the parent material. Locking pins are pressed into the base of the tapped hole through the grooves in the external thread.

Still another, a solid bushing, has standard internal and external threads and an expandable upper collar with serrations in the outer surface to lock the insert in the parent material.

Factors that affect selection

These factors must be considered in selecting the best type:

- Shear strength of parent material
- Operating temperature
- Load requirement
- Vibratory loads
- Assembly tooling—serviceability and ease of installation
- Relative cost

Shear strength of parent material below 40,000 psi generally calls for threaded inserts. This includes most of the aluminum alloys, all magnesium alloys and plastic materials. But other factors must be considered.

High operating temperature effects the shear strength by reducing strength of the parent material; an insert with a larger shear area may be required.

Bolt loading frequently makes it necessary to use threaded inserts. For example, if the full pull-out strength of a 125,000-psi bolt is required, it is probable that the parent material will need a threaded insert to increase the shear area and thus reduce the effective shear stress.

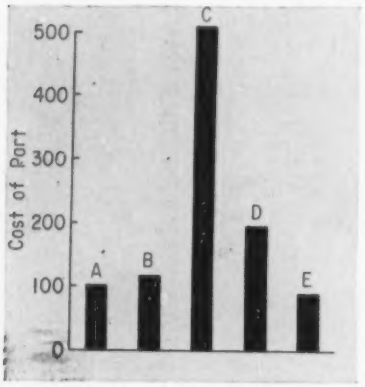
Vibratory loads may reduce bolt preload, and require a threaded insert to increase the effective shear area. Or vibration may cause creep, galling, and excessive wear, and inserts with both external and internal thread-locking features will be needed.

The pullout capacity of an insert is a function of projected shear area, and should equal the tensile strength of the bolt. This means pull-out strength should be greater than torque-applied tensile strength of the bolt.

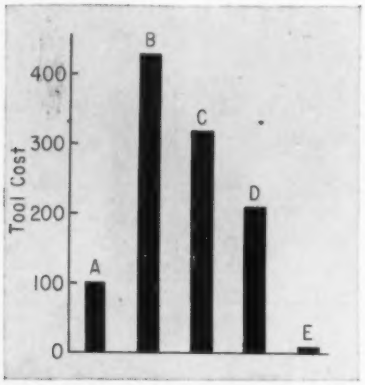
In wire thread inserts the projected shear area per coil

RELATIVE EVALUATION—5 TYPES OF THREAD INSERTS

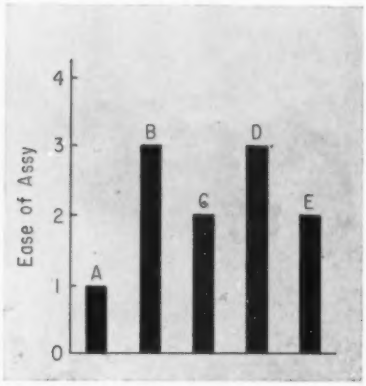
(A—self-tapping insert; B—wire thread insert; C—solid bushing for pre-tapped holes; D—solid bushings for pre-tapped holes and external interference threads; E—self-tapping insert)



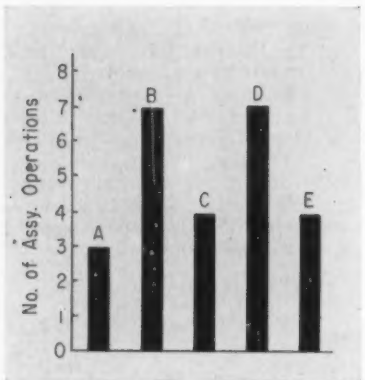
COST OF PART is price quoted for lots of 1000.



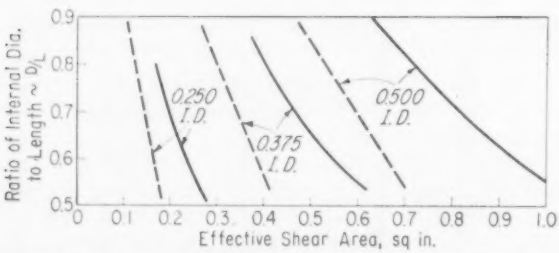
TOOL COST for each type is based on manufacturer's prices for tooling a standard tapping head.



EASE OF ASSEMBLY is a qualitative evaluation.



NUMBER OF ASSEMBLY OPERATIONS covers complete installation of an insert, including drill, counterbore, tap, ream, install and reinspect.



A USEFUL RELATION is effective shear area to D/L ratio. It determines required insert length or pull-out strength. Solid curves are for self-tapping inserts; dotted curves for wire thread inserts.

is relatively small; only way to increase the total projected shear area is to increase the number of coils. On the other hand, in solid and self-tapping inserts the projected shear area can be increased by a larger OD as well as by more threads, while maintaining the same bolt diameter.

One way to determine adequacy of pull-out capacity is to plot the ratio of the internal diameter vs insert length as a function of the effective shear area developed in the parent material. The accompanying curves for three sizes of self-tapping and wire thread inserts were derived from tests in which the insert was pulled out of the parent material. Similar curves could be developed to determine the length needed for any other type of insert.

For example, assume that a $\frac{1}{4}$-28 bolt with an ultimate strength of 5000 lb is to be used in a material with a shear strength of 20,000 psi. The required shear area is 5000 lb/20,000 psi = 0.25 sq in. From the accompanying curves, the D/L ratio is 0.57; insert length, $L = 0.25/0.57 = 0.438$ in.

Similar calculations, using the same curves, can determine whether length of the insert is sufficient to give a required amount of creep resistance: The creep strength of the parent material is substituted for shear strength in the above calculation.

Also, if the insert length is limited, these calculations will give the available pull-out strength, which will vary with shear area of the insert. This analysis can be used to determine either the required length or pull-out strength, and from this, the thickness of the parent material for minimum weight and maximum economy.

Solid threaded bushings often permit using a shorter bolt than for the wire thread insert with limited shear area. With a large number of fasteners in an assembly, weight saving in reduction of parent material is much greater than the small extra weight added by the solid insert.

Other important factors in selecting inserts are assembly tooling, serviceability, relative cost, and ease of installation. These factors have been evaluated in the bar charts prepared by W. Moskowitz of GE's Missile and Space Vehicle Dept, Philadelphia. Data are for five types using 10-32 internal threads. Part of this information is based on estimates of the operating personnel concerning the number of assembly operations, tolerances required during installation, and relative ease of installation.

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NEW LOOK AT

TEMPERATURE-MEASURING TRANSDUCERS

Temperatures from almost absolute zero to over 1,000,000 F are now being measured—with reasonable accuracy—in engineering test labs around the world. And dozens of unusual transducers previously considered experimental are helping solve practical engineering problems. Here's a special report on the state of the art.

FRANK YEAPLE, associate editor

Touch and sight are the original temperature sensors—the human skin can detect ambient-temperature changes of a fraction of a degree, and the eye is able to estimate temperature of a radiant source within a few percent accuracy by comparing it optically with a calibrated glowing filament. However, the senses are easily fooled. For better measurements over a wider range, they must call on instruments for help.

Nearly a dozen broad classes of temperature transducers are available today, based on thermal expansion, electrical response, heat flow, aerodynamic flow, chemical reaction, thermal radiation, magnetism, nuclear resonance and combinations of these. All but the aerodynamic, magnetic and nuclear techniques are fairly common, but even the well-known methods have been substantially improved in the past several years. Let's take a look at new developments in each of the classes.

Not all temperature sensors, of course, are transducers. We also have the conventional thermometers, which include the well-known mercury bulb, liquid-vapor or gas thermometer, and bimetal strip devices. But relatively little scientific work is being done today on such conventional instruments, because their capabilities are well established (most are available to 1000 F or over). The Editor's Note on p 54 refers to many previous articles on such expansion-type (as well as electrical-response type) sensors.

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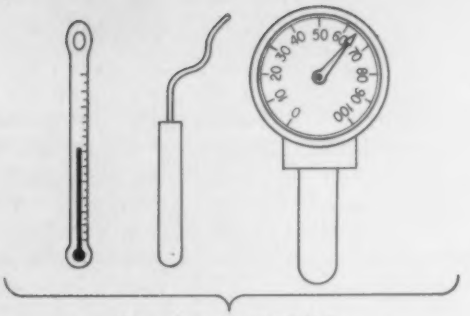
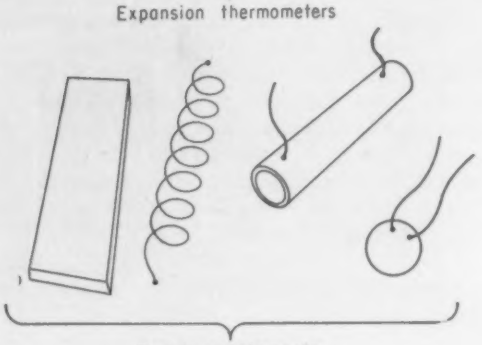
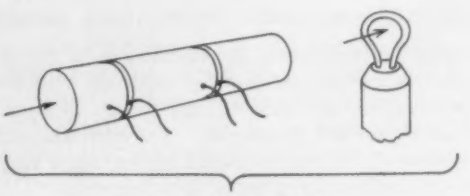


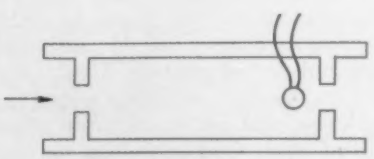
Expansion thermometers



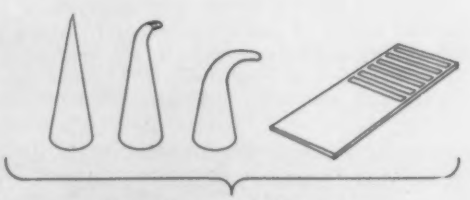
Resistance elements



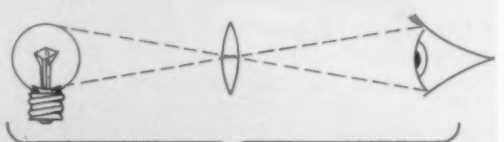
Thermal-flux probes



Aerodynamic

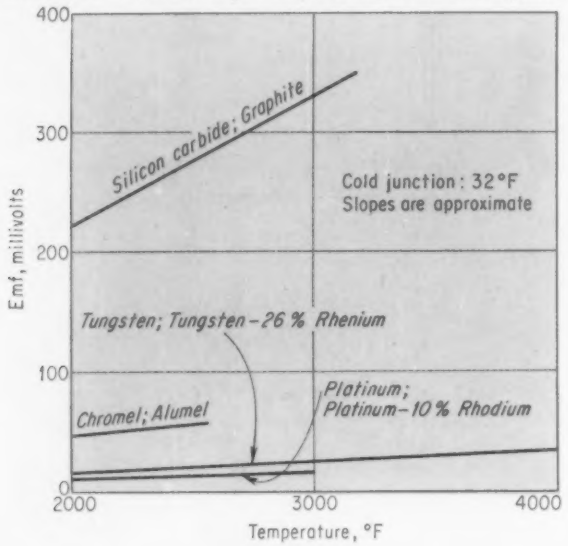


Metallurgical and chemical



Optical and photoelectric

Electrical Output of High-Temperature Thermocouples



ELECTRICAL-RESPONSE TEMPERATURE SENSORS

Among the transducers, the thermocouples, thermopiles and resistance thermometers for moderate environments are commercially available in large variety, and published data cover the field thoroughly. For very low and very high temperatures, and for special service, many significant contributions have been made in recent years.

Thermocouples

High-temperature thermocouples for adverse environments such as exhaust-gas streams have been greatly improved. Temperatures to 4000 F can be withstood by new refractory-metal couples and by nonmetal couples such as silicon carbide and graphite. Metal couples show more promise because they are easier to make, are electrically more stable, and are mechanically stronger than the carbon-based types. The latter have remarkably high voltage output, however, and for certain jobs should prove invaluable. The accompanying graph shows relative electrical output of three different thermocouples.

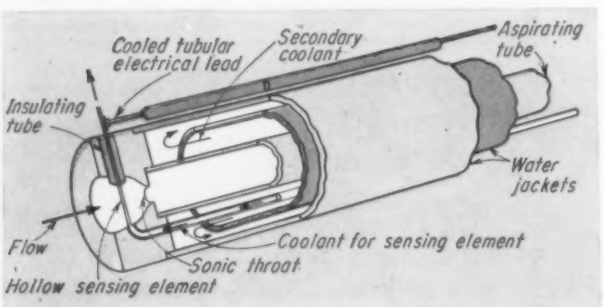
Chemical nature of the environment is extremely important at elevated temperatures. For measuring temperature of liquid or gas with refractory-metal thermocouples (tungsten, rhenium, tantalum, molybdenum, iridium, platinum, etc.) these four environment classes are important: (1) oxidizing atmosphere (favors a chemical change of the probe material by increasing the proportion of its negative element—as by adding oxygen or removing hydrogen); a reducing atmosphere (the converse of an oxidizing atmosphere); an inert environment; and a vacuum. It is necessary to specify which will be encountered, because a different couple may be required in each instance.

Another problem at high temperatures is specifying a suitable electrical insulation for the wires. Besides good thermal conductivity, it should have a thermal-expansion coefficient near that of the metals in the couple. Thoria—an oxide of thorium—combines many of the needed properties. Also needed is sheathing material that stays strong at 4000 F. Molybdenum is one choice.

Accuracy and repeatability of any basic high-temperature couple are reasonably good under lab conditions. For most couples, the accuracy can be much better than ½% of measured temperature. But in actual operation, where deterioration and contamination combine with normal uncertainties such as thermal radiation, condition, and convection losses, the errors can easily exceed 5 or 10% of the reading. Measurement under such conditions is an art too complex to discuss here.

Extreme-temperature thermocouple measurements to 9000 F are possible with intermittent-type couples. These are ordinary high-temperature couples shuttled back and forth between the hot environment and a watercooled jacket. The percent time at each position determines the mean temperature (calibration is required). Fast cycling gives the best accuracy. One successful device has a Chromel-Alumel couple cycled up to about 3 cps with a double-acting solenoid. An ancestor of the intermittent device is the immersion couple used in the steel industry: it is immersed only long enough to reach the molten-steel temperature.

Fast-response thermocouples should have small mass and large surface area. Both are achieved in a novel, although not new, couple with an insulated wire inside a strong tube of a different material. A thin metal film is plated onto the sensing end, connecting the two materials and



WATER-COOLED RESISTANCE-TYPE temperature probe measures heat flux between surroundings and an internally cooled glass tube. A platinum coating about 5 millionths in. thick on the surface of the sensing element (0.006-in.-dia glass tube) is automatically kept at constant resistance (hence, constant temperature) by a fast-response electrical bridge circuit. Heat transfer from platinum surface to interior coolant is therefore constant. With the tubular sensitive element mounted in a constant Mach-number section of an aspirating probe, the gas temperature is an inverse function of the balancing watts. Response time is a fraction of a millisec.

serving as the junction. (In some versions, the junction is formed by rubbing the sensing end with coarse emery paper.) This thermocouple is ideal for measuring fast-changing surface temperatures because the junction is only the thickness of the plating away from the hot environment. Many of these are used to measure cylinder-wall temperatures in engines or rifles: here, the plated tip is flush with the exposed inner surface.

Rotating machinery such as turbines can be instrumented, but sliprings are needed to bring out the thermocouple leads. Over-all accuracies can be within ±2 deg. F (better than ±0.1%) if extreme care is taken. The thermocouple wires must be made of almost perfectly homogeneous materials to avoid generating spurious signals in the high-temperature gradients encountered.

In one design—for a jet engine test—the slipring incorporates silver rings and silver-graphite brushes in a novel arrangement featuring a single sliding junction for each thermocouple. To test the complete instrumentation—thermocouple, slipring and recorder—a miniature sealed pot filled with lead is mounted on the turbine wheel at one of the measurement points. A thermocouple in this melting pot is read on the recorder; error can be easily detected because the melting point of lead is known exactly and can be compared with static calibration of the couple. Readings of the lead-pot and wheel temperatures should coincide exactly except at the melting point —there the temperature slope will flatten out during melting (or solidifying) only.

Both temperature and strain can be measured through the same wires and slipring assembly. A strain gage is put in series with each thermocouple; for temperature readings, the circuit is not energized, and output is proportional to temperature. For strain readings, the circuit is energized and resistance changes can be measured with a bridge circuit.

Thermopiles are arrays of thermocouples joined in series to form a single compact unit—useful in reading small changes in temperature. One interesting version is named the "heatburst microcalorimeter" because it has 10,000 couples over a wide surface area and measures reaction temperatures of liquid chemicals poured over it. Method is fast and precise, and is also useful in measuring free energy, entropy and other thermodynamic changes. Thermopiles are also used in some radiation pyrometers.

Resistance thermometers

Resistance thermometers are electrically conducting sensors that vary in resistance as a function of temperature. Electrical measuring equipment helps read the resistance. The National Bureau of Standards resistance standard is platinum wire (a sample length is retained by NBS for permanent reference). But other conductor or semiconductor materials—and other shapes, such as vapor-deposited films—may be chosen for the sensing elements, depending on the need. Copper, nickel, tungsten, carbon, germanium, and diamond are possible choices, and temperatures in the range from about −450 to 5000 F can be measured.

As a new standard of reference, resistance thermometers of high-purity platinum are being developed by NBS to give close accuracy to 2000 F. (There are already commercial resistance thermometers for 2000-F temperatures and higher—to 3000 F for short transients—but these are more rugged and less precise.) To prevent damage, to minimize strain-induced resistance changes, and to avoid contamination of the platinum by adjacent materials, great care is taken to provide compatible, strain-free mounts for the coiled platinum wire.

Extremely high temperatures—up to the melting point of the material in the probe—can also be measured with resistance elements, but the probe is destroyed. An example is measuring the surface temperature of ablating silica in a missile nosecone undergoing test. A piece of tungsten wire imbedded in the silica increases in resistance gradually with temperature until the instant when the surface ablates back as far as the wire. The wire now burns through instantly and the resistance jumps. The last reading before the jump indicates temperature. Values over 5500 F have been recorded.

Thermistors are semiconductors that change electrical resistance markedly with temperature. In some types the resistance increases with temperature (PTC), but most have "negative temperature coefficients" (NTC). External instruments measure the resistance and are calibrated for temperature.

Low-temperature thermistors of germanium have been developed for temperatures down to about −450 F, and accuracy is good. They are considered better than metal resistors in this range because semiconductor resistance is inherently higher and therefore miniature units are easier to build. Furthermore, resistance increases greatly as temperature drops, eliminating lead-resistance problems.

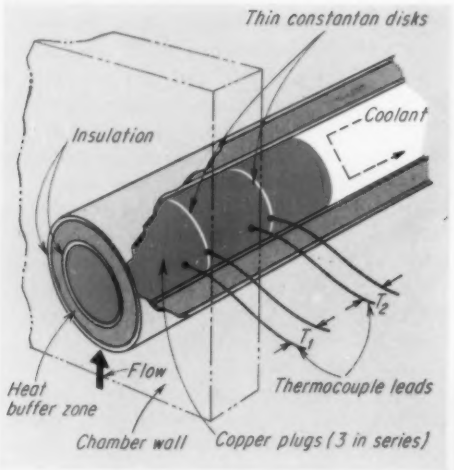
Some high-temperature thermistors (up to 1500 F claimed) are being developed commercially. Even the diamond, which has semiconductor properties, is serving as a thermistor. It measures temperatures to 480 F (*PE*—Aug 8 '60, p 8).

Thermistors have these disadvantages. They are sensitive to magnetic fields. Response is nonlinear. It is difficult to make thermistors with reproducible properties (single-crystal semiconductors have the most reproducible properties). However, big improvements are being made constantly, and thermistors will eventually be an acceptable secondary standard (platinum is the primary one).

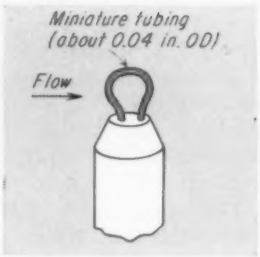
Metal film is the resistance element in one unusual temperature-measuring application—a liquid-cooled resistance thermometer. Sketch on previous page shows the principle of operation.

Readings for any resistance thermometer are taken with remote or integral instruments such as Wheatstone bridges, and must be translated into temperature. Response of the sensor to temperature is not always linear, and with thermistors it is extremely nonlinear. However, linear readout is possible if the reading instrument is designed to compensate exactly for nonlinearity in the sensor. Such compensating devices are available for some thermistors and most other resistance elements.

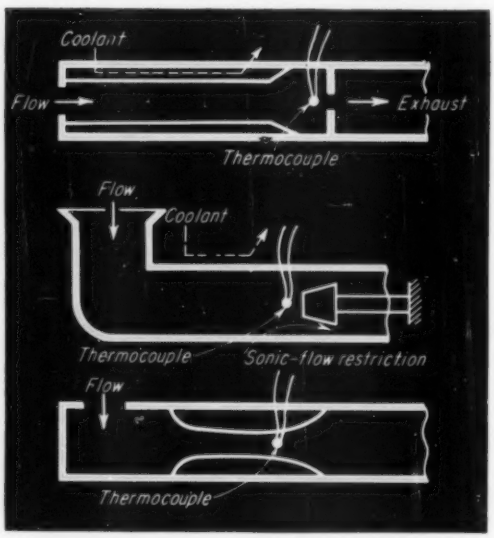
Readout accuracy (external) is not a problem: it can be very good for calibrated equipment. Much greater



HEAT-FLUX TEMPERATURE PROBE literally "pipes" the heat from the hot chamber surface to the cooled end. Thermocouples T_1 and T_2—located in a relatively cool portion of the heat path—help measure the gradient, and chamber temperature is deduced from this by extrapolation. Each thermocouple pair is copper (the plug itself) and constantan (thin disk between each pair of plugs).



COOLED-TUBE PROBE has coolant continuosly circulated through the loop of tubing. Temperature rise of the coolant is an indication of stream temperature being measured.



NOZZLE-TYPE TEMPERATURE PROBES (3 types shown) expand the gas through one or two restrictions. The upper two types reduce temperature to a more easily measurable value. Bottom type measures actual temperature at sonic conditions where heat transfer is a maximum. Perfect-gas laws of thermodynamics enable stream temperature to be deduced from temperature and pressure readings.

error occurs at the sensor, where convection, conduction, radiation and contamination combine to falsify readings.

Pyroelectrics

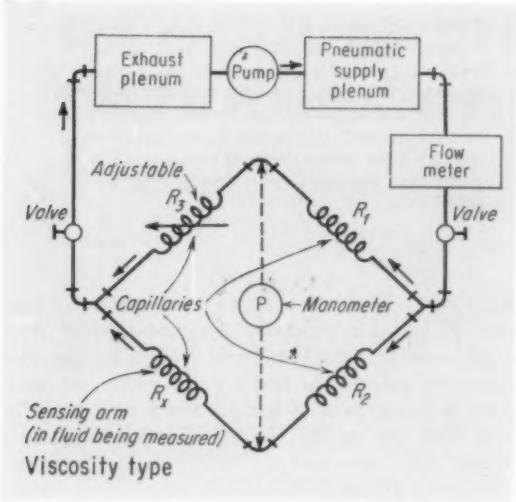
These measure changes in temperature, but not the absolute value. Some examples of pyroelectrics are barium titanate ceramic, Rochelle salt, tourmaline, and potassium dihydrogen phosphate; each develops an electrical potential during a temperature transient. The phenomenon depends on spontaneous polarization in the crystal lattice, and the electrical charge developed during the transient is extremely small. Special instruments can measure this voltage. Temperature changes as small as 3×10^{-7} F can be detected with a barium titanate element and special time-derivative measurements can be taken to establish rate of temperature rise. Recent work indicates possible applications in radiation pyrometers.

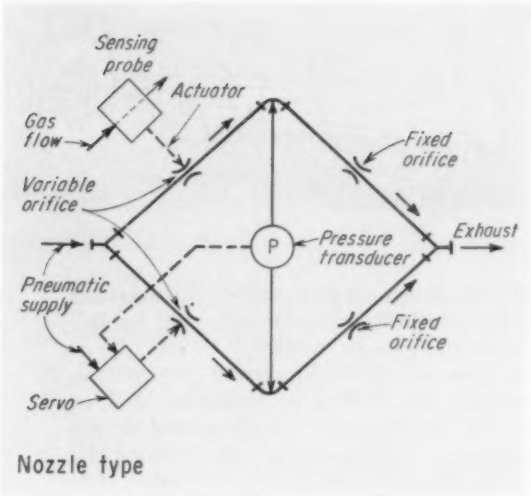
THERMAL-FLUX DEVICES

Heat flow in the sensor, instead of actual temperature of the source, is the method that distinguishes a heat-flux thermometer. Temperatures over 7000 F can be handled because the heat is in a sense "piped" away to a cooler location for the actual measurements. The true temperature is then deduced from the temperature gradient or other heat-transfer considerations, depending on the type of probe—there are several basic ones.

One typical heat-flux probe is a cylindrical thermal conductor with an insulating sleeve. Its sensing end is in the hot environment being measured. Heat is conducted to the outside end, which is kept cool. The average heat flux, btu per min. per sq in. of cross-section, is the same at all points along the path because the insulating sleeve keeps most of the heat inside the conductor. Temperature at the hot end is deduced by measuring temperature gradient at a cooler portion of the path, and extrapolating to the hot end. Sketch above shows one actual type of construction. Similar probes are used to measure wall temperatures of combustion chambers and stagnation pressures in a gas stream.

Another heat-flux probe—really an anti-heat-flux probe—stops heat flow instead of measuring it. It works this way: the probe has two thermocouples—one near the tip, and one back from the tip. A closely controlled auxiliary heater warms the probe in back of the second couple until it reads the same as the tip couple. This dual reading is very accurate because axial heat loss along the probe is





PNEUMATIC-BRIDGE temperature-measuring circuits resemble electrical Wheatstone bridges in that an unbalance in one leg (caused by a temperature change) can be balanced by varying the companion leg. **Viscosity type**, left, has sensing capillary right in the stream being measured; viscosity of the pneumatic fluid (a closed circuit in this version) varies with temperature. The adjustable capillary balances the bridge and its setting indicates temperature. **Nozzle type**, right, has a separate sensing element, but its pneumatic output is read with the bridge. Servo position indicates temperature.

stopped (temperature gradient has been reduced to zero) and therefore the effects of external environment are eliminated. However, the thermocouples sense full temperature and therefore limit the allowable probe temperature.

The cooled-tube probe is a loop of miniature hydraulic tubing through which coolant flows. Temperature rise of the coolant and its flow are a measure of the surface temperature of the probe. Normally the probe is used in gas streams, and surface heat-transfer characteristics must also be known. A typical cooled-tube probe is shown on top of previous page.

Heat-flux sensors of any type in a gas stream depend on complex heat-transfer relationships – thermodynamic properties, surface-transfer coefficients, conduction through the probe, and probe heat capacity (for transients)–careful calibration of the over-all system is essential.

AERODYNAMIC TEMPERATURE SENSORS

For gas-stream temperatures too hot to measure directly with ordinary thermometers or thermocouples, there are aerodynamic devices to help compute temperature from gas properties and thermodynamic behavior. If the gas stream pressure is greater than atmospheric, bleed-off nozzle-type sensors will work. For low gas pressures, a suction source is used to draw the gas through the probe.

Nozzle-type temperature probes are the simplest–several are shown in the sketches on previous page. In two types, the gas is expanded, then cooled so its temperature can be read. The original gas-stream temperature can be computed with ordinary thermodynamic relationships if the gas composition is known and proper pressure and temperature readings are taken. With critical-flow nozzles–in which the gas flows at speed of sound through the throat of the nozzle–the temperature is a simple function of the pressure and the flow, both of which can be measured easily and accurately. With orifices, measure pressure differences.

Pneumatic-bridge temperature detectors are groups of capillaries or nozzles arranged in a bridge circuit resembling the electrical Wheatstone bridge. Two versions are shown in the sketches above. Gas-stream temperature is "inferred" from readings of pneumatic pressures and temperatures, and ordinary thermodynamic relationships apply. Temperatures from −400 to 2700 F have been measured this way, and much higher values are feasible.

Acoustic temperature-measuring devices measure the speed of sound through the gas (it should be at a fairly low pressure for best accuracy); temperature is computed from known gas properties. There is no upper limit to temperatures that can be measured, but there is a lack of published data on necessary gas properties.

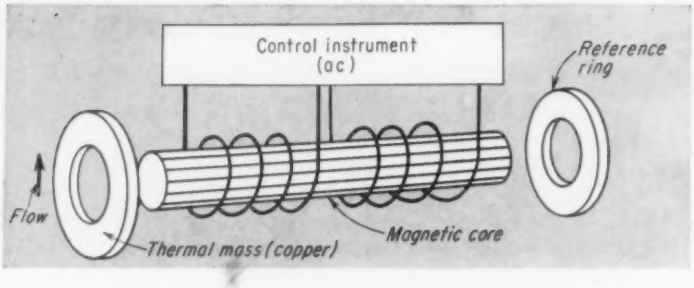
CHEMICAL AND METALLURGICAL SENSORS

Fusible solids and temperature-sensitive coatings can be designed to react or melt at a given temperature. A different composition is needed for each basic temperature or temperature range, but they are available for practically every temperature from 100 to 2000 F and higher.

THERMAL-RADIATION DEVICES

The characteristic thermal or visible radiation of a fluid or solid is an indication of its temperature. Radiant-energy measuring devices are often called pyrometers.

continued, next page



MAGNETIC TEMPERATURE TRANSDUCER (exploded view) can sense temperature by measuring the "coupling" between ac magnetic field and eddy currents induced in the thermal-mass ring by the coil. Electrical resistance of the copper changes with temperature; balancing circuits measure change in coupling flux. (Device is normally used to measure heat-transfer rate from a fluid to the thermal mass—response time for step input is a fraction of a millisec.)

(By definition a pyrometer can be any device that measures high temperatures—including thermocouples—but for this article only radiation types are meant.)

The sensor does not physically contact the emitting surface or volume, and there is no theoretical limit on temperatures that can be read. (Spectroscopic devices can measure plasma temperatures to over 1,000,000 F.) Problem is that each surface or volume has unique emission characteristics, and these must be known beforehand or large errors will result.

Solid surfaces vary in their emissivity—from surface to surface and even from temperature to temperature. Gray or black bodies (high emissivity) are easiest to sense because their response is predictable.

Gases have widely varying emission characteristics and a special chart is needed for each. As temperatures rise, emission becomes more complex and available data on properties become scarcer.

To solve these problems, a wide variety of techniques have been developed—some recently. One important approach, though not a new one, is to optically filter out all but the desired "colors" so that the reading instrument can concentrate on one or two wavelengths at a time.

A one-color radiation pyrometer reads the varying intensity of a single wavelength with temperature, but it is affected by changes in emissivity. A two-color pyrometer reads two wavelengths, and compares the ratio of the intensities, thus partly cancelling out any effect of emissivity change. But if emissivity for each wavelength has a unique pattern of change, then a two-color pyrometer is little better than the one-color variety.

MISCELLANEOUS SENSORS

There are many novel temperature transducers that fit no single class designation. They are unique or are combinations of two types. Here are three examples.

Ablating-conductor probes in a plasma jet can become part of an electric circuit comprising the arc electrode, the plasma (a conductor), the probe, and a return path. The circulating currents are high—up to tens of amperes if needed. Such probes can be instrumented with Wheatstone bridges to detect the change of path resistance (arc-plasma-probe). This change is a function of plasma conductivity which in turn is extremely sensitive to plasma temperature.

Magnetic fields help operate two unusual temperature transducers. The first, with an ac coil magnetically coupled to a temperature-sensitive eddy-current disk, is sketched above. The other (not shown) is a nuclear-resonance device that generates a radio-frequency field in the gas volume being measured. By adjusting the frequency, it is possible to find a point where the spinning poles in the nucleus of the gas atoms tend to be in resonance with the applied field. This tends to align the nuclear "spin" axis, and the energy change is detectable. Resonant frequency is a function of temperature.

ACKNOWLEDGEMENTS

Most of the information in this article was obtained during the recent Symposium on Temperature in Columbus, Ohio, sponsored by American Institute of Physics, Instrument Society of America and National Bureau of Standards. Our particular thanks to Dr C. M. Herzfeld, Chief of Heat Div, NBS, and W. A. Wildhack, also of NBS and General Chairman of the Symposium, for filling in some of the background for the story. PRODUCT ENGINEERING is also grateful to the Symposium Committee for permitting us to draw upon speeches, papers, and conversations with the experts to develop this report—many of the speakers subsequently supplied us with additional information.

EDITOR'S NOTE: Temperature measurement and related heat-transfer concepts have been covered previously:

Temperature Measurement in Solids, July 21 '58, p 65—Thermocouples, resistance elements and thermistors are compared, and special skin-metal-disk thermocouples are described. Bibliography of previous PE articles on temperature is included.

Fast-response Temperature Controls, Jun 12 '61, p 40—Briefly surveys all common temperature sensors and compares response speeds.

Which Heat Protector for the Motor, Sep 12 '60, p 53—Has detailed performance comparisons of all the new inherent (inside-the-motor) protectors such as thermistors, resistance elements, miniature snap-switches, rod-and-tube elements, and others; also a direct comparison of remote vs inherent protection.

Temperature-measuring Devices, Feb '50, p 138—Compares bulb, bimetal, thermocouple, pyrometer, resistance and melting-cone types of sensing elements.

High-force Thermostatic Actuators, July 11 '60, p 74—Solid-liquid-phase (hydrocarbon wax) actuators vie with rod-and-tube and bellows-type actuators. Article describes all of them, gives detailed performance comparisons.

Infrared for Heating a Product, Feb 1 '60, p 39—Comparisons in performance of radiant, induction, dielectric, resistance and other heating methods. Has general discussion of the theory of radiant heating, and simple charts that help make quick estimates of heat transfer.

Radiant Cooling or Shielding, Nov 14 '60, p 55—Shows how to exploit high temperatures by letting unwanted heat radiate away. Also gives details on emissivity measurements, with tables of typical values for important materials.

The papers from the 1961 Temperature Symposium will eventually be published in book form. Texts of the two previous symposiums (1939 and 1954) are available.

DESIGNING SHELLS FOR EXTERNAL PRESSURE

Two nomographs find wall thickness needed to prevent splitting of thick-wall cylinders or buckling of thin ones.

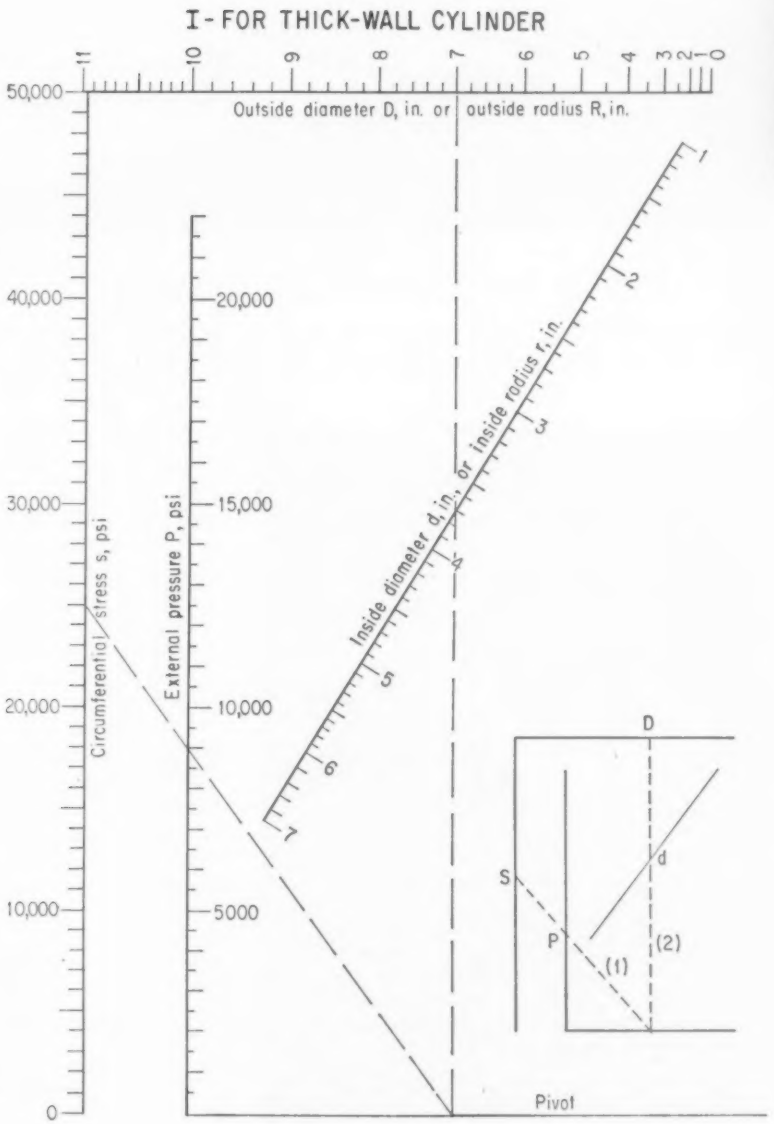
F CAPLAN,
Senior engineer
Kaiser Engineers, Div of Henry J Kaiser Co
Oakland, Calif

Thick-wall cylinders

Where $(R\text{-}r) > r/10$, hoop stress is a maximum at the inner wall when pressure is external. Nomograph at right solves the equation: $s = 2PD^2/(D^2\text{-}d)$. With it you can solve for thickness, stress or pressure.

EXAMPLE: What should be the inside diameter of a cylinder if $D = 7$, $P = 9000$ and the limit for $s = 25{,}000$?

Lines for sample problem on nomograph lead to answer, $d = 3.69$, so $r = 3.69/2 = 1.84$ in.



SYMBOLS

- D = Outside dia of cylinder, in.
- d = Inside dia of cylinder, in.
- P = External pressure, psi
- R = Outside radius of cylinder, in.
- r = Inside radius of cylinder, in.
- s = Hoop stress at inner surface of cylinder, psi

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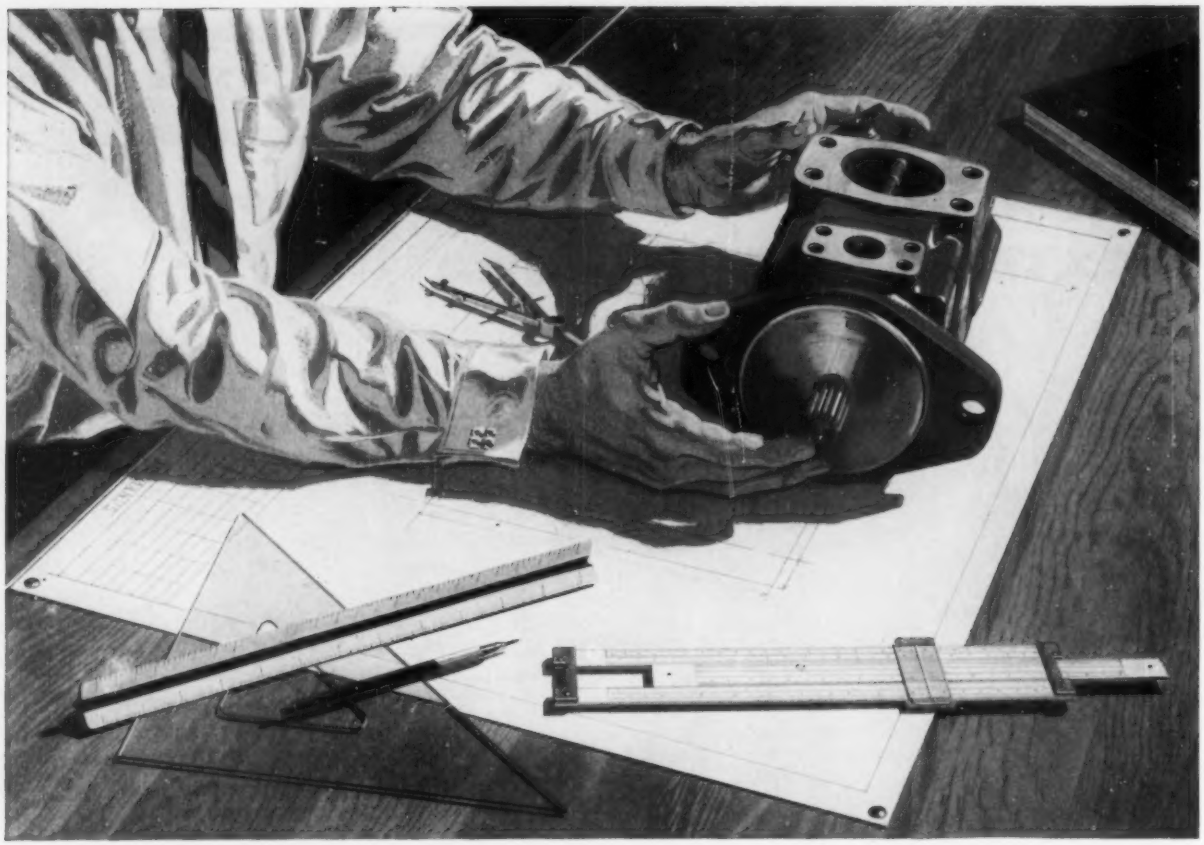

IF YOU BUILD MOBILE EQUIPMENT...

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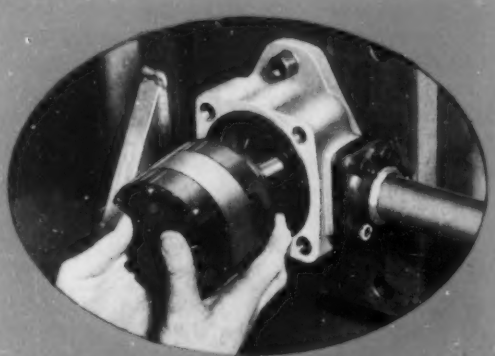

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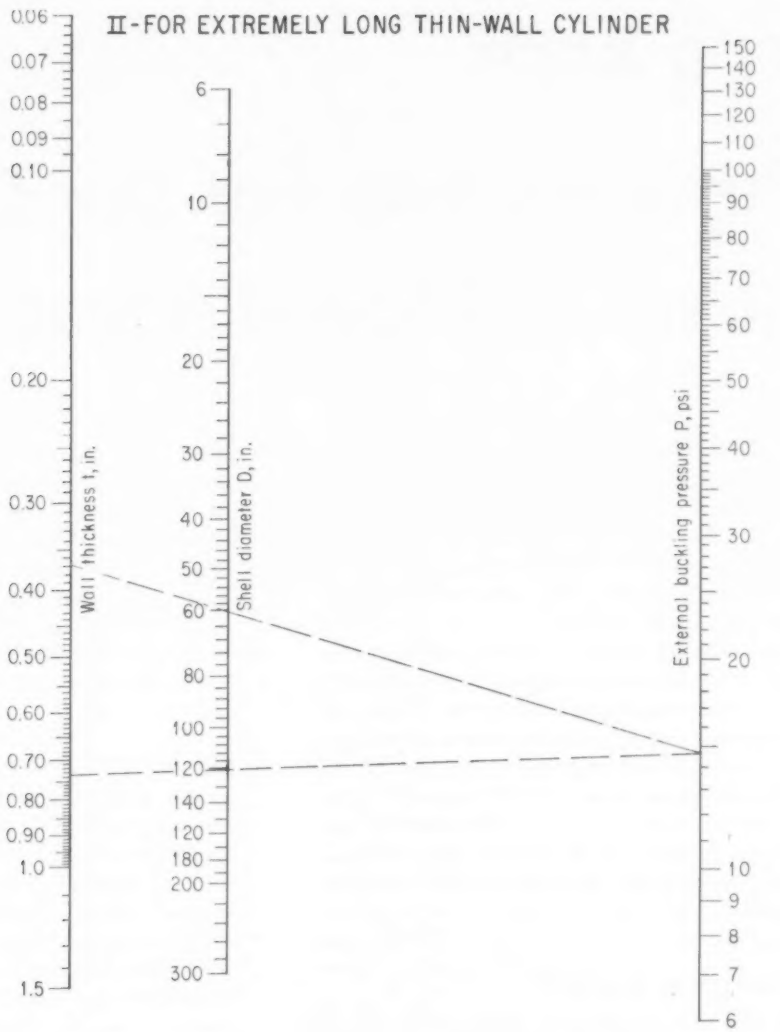
DESIGNING SHELLS FOR EXTERNAL PRESSURE continued



SYMBOLS

D = Dia of cylinder, in.
L = Length of cylinder, in.
P = External pressure, psi
r = Radius of cylinder, in.
t = Thickness of shell, in.

Thin-wall cylinders

Failure under external pressure is by buckling at stresses within the proportional limit, not by metal fracture. For long cylinders, where $L > 4.90r\ (r/t)^{\frac{1}{2}}$, nomograph above solves for thickness at which the cylinder will buckle: $t = 0.0025DP^{\frac{1}{2}}$. This is a simplified equation arrived at by assuming modulus of elasticity $E = 30 \times 10^6$ and Poisson's ratio $\mu = 0.25$ in the equation for buckling pressure: $P = Et^3/4r^3\ (1\text{-}\mu)$.

EXAMPLE: What is minimum wall thickness to prevent buckling of a long cylinder with a complete vacuum inside if $D = 60$ in? Draw single line on nomograph to find $t = 0.3068$ in.

LET'S KEEP

Business Help For Our Colleges Going Full Speed Ahead

"Should our company fold up its program of financial help for higher education now that the Kennedy Administration plans to have the federal government provide this kind of help in a big way?" It is clear why, in the light of campaign promises and plans announced since, this question is being raised in many business firms at this juncture.

What seems far clearer, however, is the right answer to the question. It is a resounding NO! **This is no time for the business community to ease up in what have been its notably successful efforts to help our colleges and universities get out of the deep financial hole in which they are operating. On the contrary, this is the time to put more steam than ever behind the drive of business to increase its financial help for higher education.**

Massive Help Needed

It is easy to understand why any individual businessman or firm might have a rather despairing feeling about the prospect of competing with the federal government, with its almost all-embracing tax arm, in providing financial support for higher education or almost anything else for that matter. But this is not a case of competition. It is a case where our colleges and universities must have massive help all along the line if they are to be put squarely back on their feet financially—a goal of crucial and perhaps decisive national importance. **The business community will continue to have both the opportunity and the obligation to keep on increasing its help for higher education as rapidly as possible.**

To underline this proposition take a look at the chart at the top of the next page. It shows how far the salaries of college and university faculty members continue to lag behind those of other occupational groups in the U.S.A. There has been some relative improvement in the average of faculty salaries in recent years. And the salary improvement in some fields, such as those of science and mathematics, has been very pronounced. But the chart makes clear how badly the average salary of college and university faculty members still lags.

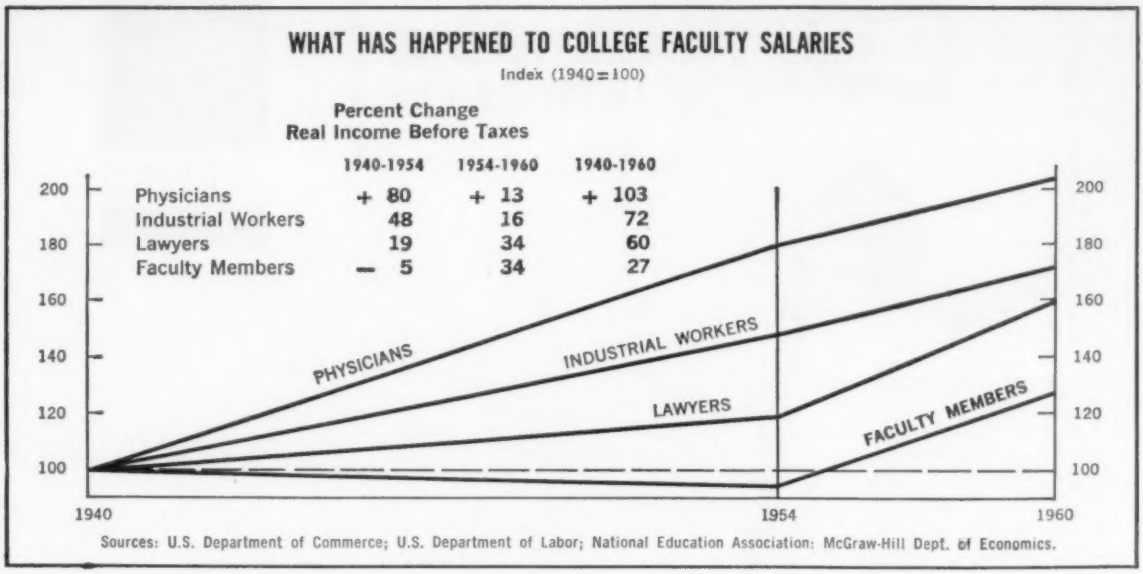
No Federal Funds For Salaries

The plans for increased financial aid for higher education, proposed by President Kennedy, do not contemplate increased expenditure for faculty salaries. This, we believe, is wise whether or not you feel, as many do, that resort to this kind of federal financing would inevitably carry with it federal controls that would ultimately undermine academic independence. The fight over federal appropriations for faculty salaries would be so long and bitter that it would be destructive to the aid program as a whole.

However, what the federal government will not be doing to remedy the deplorable condition of faculty salaries, as reported by the chart, is one indication of the tremendous scope that remains for crucially important help for higher education from business. Manifold other indications are available.

Disaster Escape Route

One of these indications is provided by the careful calculation that the annual income of our colleges and universities must be increased by about $4½ billion (from about $4½ billion to about $9 billion) over the next eight years if the tremendous wave of students



now gathering to descend on these institutions is not to wind up in both a financial and an educational disaster. This wave promises to add more than 2.5 million, or 75%, to college enrollments by 1970.

Thus far, the program for financial help for higher education by business, spearheaded by the Council for Financial Aid to Education, has been a remarkable success in all dimensions. The dollars contributed have increased rapidly—from about $100 million five years ago to about $150 million this year. Contributions of $500 million a year by 1970 are a clear possibility.

One of the inspiring developments increasing this possibility stems out of Cleveland, Ohio. There through their chief executives, an imposing group of business firms have established one per cent of their profits before taxes as their minimum goal for contributions to higher education, to be reached within three years. General acceptance of this goal by business would go most of the way toward getting our colleges and universities firmly on their feet financially.

Mutual Respect Increased

The mutual esteem of the academic community and the business community, an element of enormous importance to a free society, has been increased by the manner in which the program of financial aid has been carried out. In making its contribution, there has been no attempt whatsoever on the part of business to encroach upon the academic freedom of the institutions financially benefited. And the program of financial aid has greatly increased the knowledge, understanding and respect which the colleges and universities and business have for each other.

The Kennedy Administration's program to enlarge federal financial support of higher education is certain to arouse strenuous controversy. As proposed by its Task Force, it avoids some of the most controverial areas of principle. However, the very magnitude of the proposed extension of the federal government's already vast program of financing higher education involves fighting issues.

But if the enlargement of federal aid were to be deeply discouraging to the continued expansion of private aid for higher education, it would be a national misfortune of major proportions. There is no good reason why it should be. On the contrary, there is compelling reason for the business community to continue giving higher education all the financial help it possibly can, thus speeding onward a program that has been and continues to be a major constructive force for our colleges and universities, for business and for the nation.

This message was prepared by my staff associates as part of our company-wide effort to report on major new developments in American business and industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.

Donald C. McGraw

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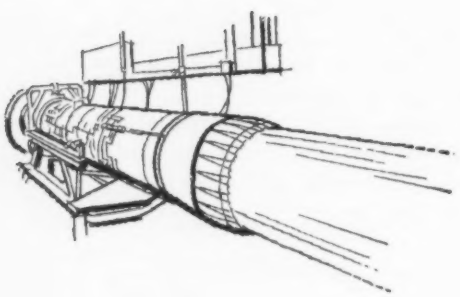

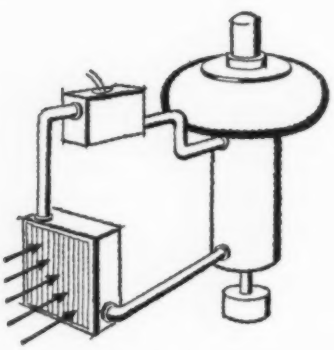

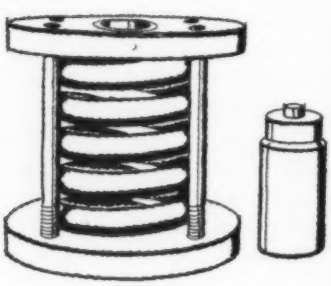

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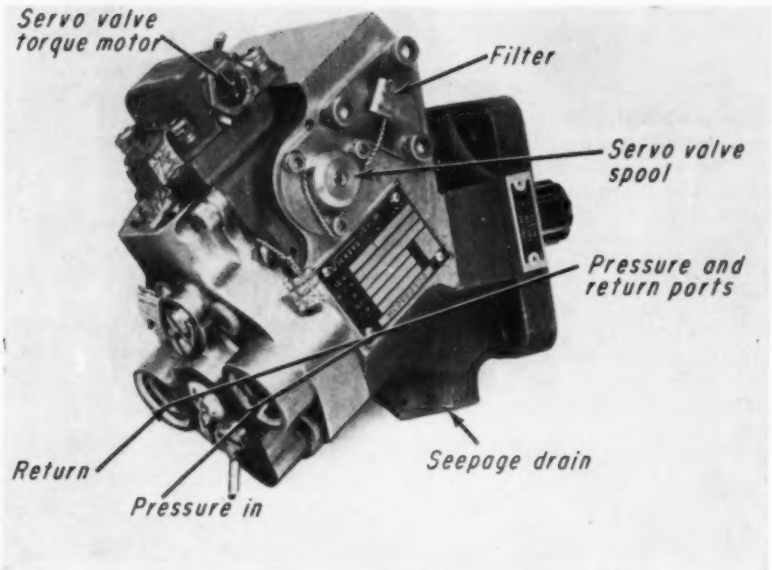
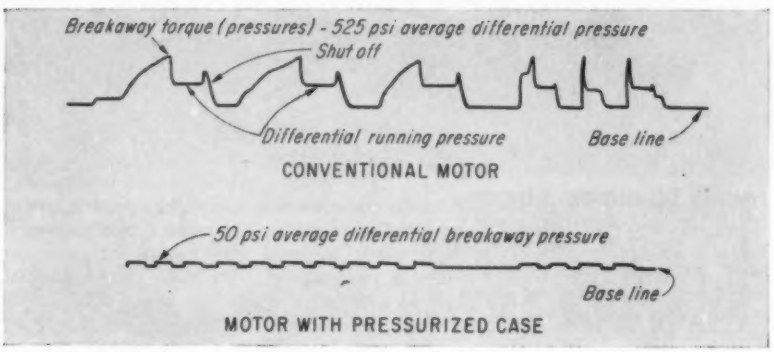
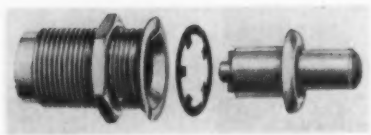




Pressurizing hydraulic-motor case . . .

reduces breakaway pressure to 50 psi from 525 psi needed for standard design with unpressurized case. (See above for pressure differential recording in tests on two motors under identical conditions. Conventional motor curve is at top; motor with pressurized case at bottom). By building control valve integral with motor, size and weight of overall package are reduced and hydraulic lines connecting motor and valve manifold are eliminated. Resulting short passages cut amount of required pressurized fluid and increase motor's dynamic response. Check valves are used to connect alternating motor pressure and return lines with supply line ahead of filter and valve. This prevents motor port pressures from rising beyond supply pressure during motor deceleration. Motor case is filled with hydraulic fluid and automatically kept at a pressure intermediate between motor supply and return pressures. Case fluid lubricates and "floats" motor's moving parts, reducing running friction. Bearing loads are reduced, permitting use of fewer and smaller bearings and at same time increasing their reliability. This floating action of case fluid also reduces high stiction (stick-slip) forces present during start and at low speeds in conventional hydraulic motors. Pressures are equalized inside motor during standby, eliminating internal leakage. Motor originally designed for position and velocity servo systems. Available in 3906 size with rating of 0.095 cu in. per revolution. **Vickers Inc, Div of Sperry Rand Corp, Detroit 32.**

Circle 300 on Reader Service Card



Pushbutton fastener . . .

handles over ½-in. total thickness in grip increments of 0.060 in. This reportedly minimizes tolerance buildup for manufacturers of precision equipment requiring either single or multiple fastener applications. Fastener needs only single-hole mounting; eliminates rivet holes, riveting and special tooling for production line installation. One push locks fastener; second push releases it. From stock at $18.30 per 100. **Camloc Fastener Corp, 62 Spring Valley Rd, Paramus, NJ.**

Circle 301 on Reader Service Card

Hi-temp adhesives . . .

for use up to 1000 F, are two-part systems unaffected by water, typical organic solvents and hydraulic fluid. Also said to have high electrical resistance and low thermal conductivity. Tensile strengths of adhesives with aluminum lap joints are 675 psi after 1-hr soaks at 1000 F and 450 psi after 24-hr soaks at 500 F. **Radiation Applications Inc, 36-40 37th St, Long Island City 1, NY.**

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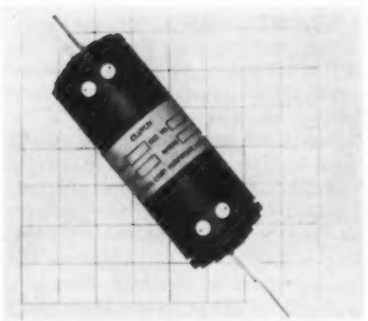

Magnetic clutch . . .

combining two clutches within single housing, has three separate operating modes. Front end includes a 0.125-in.-dia shaft passing completely through clutch within a 0.250-in-dia shaft. Other end has one 0.250-in-dia shaft. Applying current to one coil or other makes it possible to couple

Continued on page 62

0.250-in-dia shafts individually or simultaneously to 0.125-in-dia shaft. Unit available in sizes 5 to 18 with 26 to 70-oz-in. output torque at 24 to 28 v dc. Power consumption is 3 w per coil. With backlash engaged, unit has approx 5 min. max. From stock at $128 to $160 for size 11 unit (measuring 4.689 x 1.062 in. and weighing 8½ oz). **Elm Instrument Corp, 30 Chasner St, Hempstead, LI, NY.**

Circle 303 on Reader Service Card

300-v 10-amp relays . . .

save panel space by eliminating need for separate wiring troughs. Sides form wiring trough, and trough cover snaps into slots at top of each unit. All terminals are out-in-front with no double-decking to cut down wiring room or make terminals difficult to reach. With screwdriver, relays can be changed from normally open to normally closed, or vice versa, in seconds. Coils also can be changed in seconds by removing movable contact assembly. Contacts have angle-mounted springs which cause them to slide, forcing aside dust and grime particles that may accumulate on contact surfaces. Each relay takes up slightly more than 5⅜-sq-in. panel area. Available in 2-, 4-, 6- and 8-pole forms. Latched and timer forms to come. **General Electric Co, Schenectady 5.**

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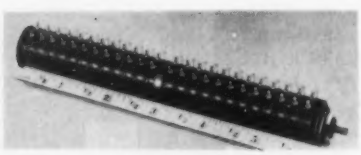


Rotary potentiometer . . .

gangs as many as 24 pots in 6 in. Individual units making up ganged series can be adjusted in less than 20 sec without affecting adjoining pots. Can be ordered with potentiometers already ganged. Simple tool phases individual units after installation. Resistance values run from 100 ohms to 200 kilohms over temperature range from −67 to 302 F. Power rating is 2 w in still air. **Daystrom Inc, Potentiometer Div, Archbald, Penna.**

Circle 305 on Reader Service Card

Control switch . . .

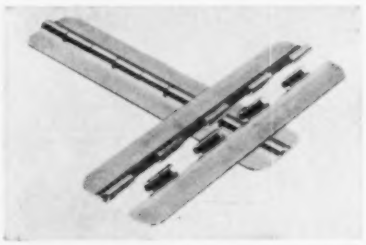
switches up to 15 amps with ⅛-microamp, or less, control signal. Operates solenoids, heaters, regulators, instruments, contact meters, etc. and has contacts that handle max of 15 amps at 115 v, 60 c ac (noninductive load) when triggered by anything from a short circuit, or zero ohms, to 10-megohm resistance. Current is amplified by vacuum tube circuit, which, in turn, energizes control relay. SPDT relay contacts are wired to control 2 normally closed and 2 normally open 3-terminal grounded female outlets. Built-in signal light goes on when switch is energized. **Central Scientific Co, Div of Cenco Instruments Corp, 1700 Irving Park Rd, Chicago 13.**

Circle 306 on Reader Service Card

Ball-and-socket joints . . .

made of borosilicate glass, do not require lubrication, are vacuum-tight and withstand up to 50 lb internal pressure. Can be joined within 10 deg of axial centers and secured with standard metal ball and socket clamps. O-rings, made of Buna-N, Hycar, silicone rubber or Tygon, remain in place on inner joint when properly seated. Available in 6-in. lengths, sizes 12/5, 18/7, 28/15 and 35/25. From stock at $2.21 to $2.65 each. **California Scientific Glass Co, 9811 E Rush St, El Monte, Calif.**

Circle 307 on Reader Service Card



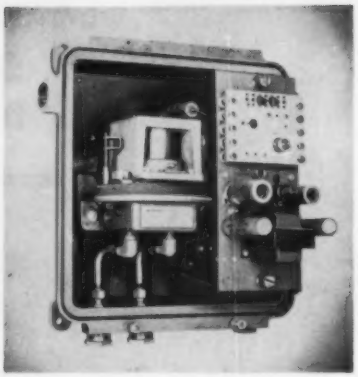
Extruded aluminum hinges . . .

for heavy or light duty, are available in lengths up to 12 ft. Can have either standard continuous design or with nodes of one hinge half slotted to permit assembly to swing open and detach. Latter eliminates necessity of spring-loaded hinge pins and allows precision closures to be maintained under heavy duty use. All hinges have 1-in. nodes and open to overall 2-in. width. **TA Mfg Corp, 4607 Alger St, Los Angeles 39.**

Circle 308 on Reader Service Card

Dual-function transducer . . .

amplifies and converts dc sensing signals to pneumatic output with accuracy of within 0.75%. Both functions are carried out within single waterproof (or explosionproof) enclosure. Unit's transmitting potentiometer uses electromechanical force-balance principle of feedback comparison to automatically compensate for transient errors arising from variations in temperature, power supply, component aging and line resistances. Conversion of electrical transmitter output to proportional pneumatic signals is accomplished by pneumatic relay section, which also uses a force-balance. Unit has no linkages, gears or other frictional parts to inhibit response. **Aeronautical & Instrument Div, Robertshaw-Fulton Controls Co, Anaheim, Calif.**



Circle 309 on Reader Service Card

Ganged light switches . . .

available single pole through 6 poles, mount on 1-in. centers. Any combination of from 2 to 12 alternate action or momentary light switches can be mounted on same channel. Mounting hardware reinforces cutouts in panel to nearly original strength for any number of units. **Color-Lite Div, Sloan Co, 7704 San Fernando Rd, Sun Valley, Calif.**

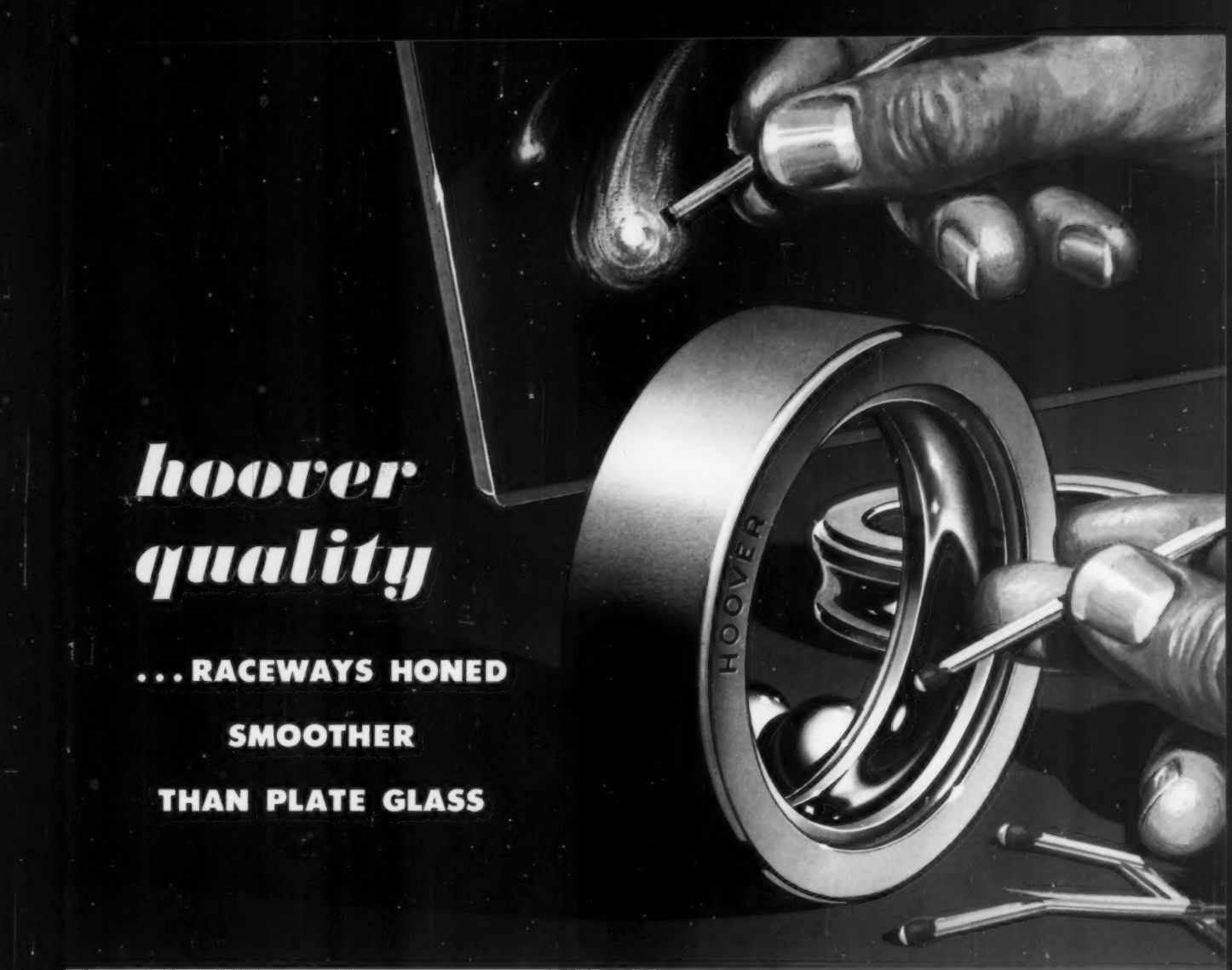
Circle 310 on Reader Service Card

Plug-in limit switch . . .

has contact gap of ⅜ in. (sum of two gaps). This greater gap width is said to eliminate cross-circuiting and wiring polarity problems and assure positive circuit breaks when switch is actuated. In tests, contacts produced from 35 to 65 million cycles at over 200 cycles per min. with inrush of 0.5 amp and interrupting current of 0.1 amp at 115 v ac. At 5 milliamp, 115 v, same contacts showed virtually no erosion at 100 million cycles. Switch has 600-v industrial control rating not limited to pilot duty; 50° overtravel in both direc-

continued on page 65

CIRCLE 63 ON READER SERVICE CARD→



hoover quality

. . . RACEWAYS HONED SMOOTHER THAN PLATE GLASS

It's easier to strike a match on plate glass than on the smooth surface of a Hoover bearing raceway. A special process, developed and used only by Hoover, hones raceways until they are ultra smooth, superbly finished. With both inner and outer raceways *Hoover Honed* to microscopic perfection, Hoover ball bearings have a distinctive quality advantage.

Equally important as the *Hoover Honed* raceways are carefully matched sets of *Micro-Velvet* balls which are accurate within millionths of an inch. These precision components work together in hushed quietness, an excellent indication of bearing quality and a characteristic of all Hoover bearings.

Outstanding quality—*Hoover Quality*—pays off in longer life, greater load capacity and superior bearing performance in a wide range of applications.

Hoover Honed and *Micro-Velvet* are Hoover Trademarks

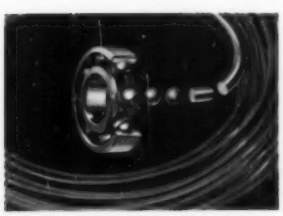
hoover

BALL AND BEARING COMPANY

5400 South State Road, Ann Arbor, Michigan

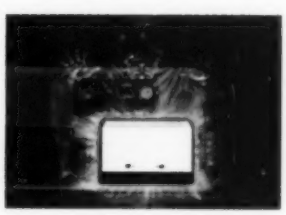
Zone Sales Offices and Warehouses | 8581 South Chicago Ave., Chicago 17, Illinois
290 Lodi Street, Hackensack, New Jersey
2020 South Figueroa, Los Angeles 7, California

hoover CONTROLS *hoover quality* FROM START TO FINISH



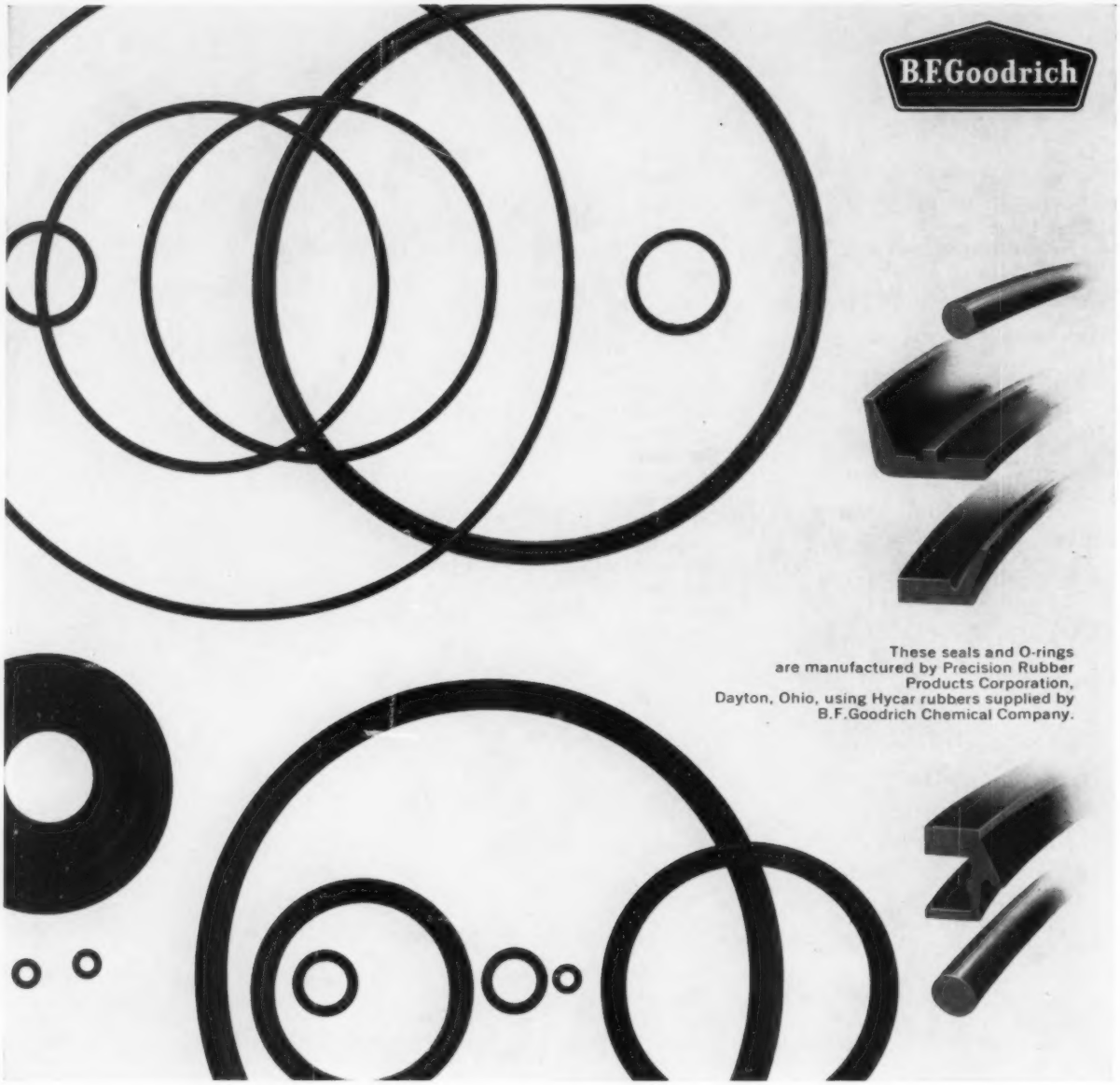
Hoover's Cuyahoga Steel and Wire Division produces quality chrome alloy steel wire from which balls are made.

Micro-Velvet balls are products of Hoover Ball Division plants in Middletown, Ohio, and Erwin, Tennessee.



Non-destructive electronic testing devices check bearing parts for tolerance, hardness and hidden flaws.

Hoover bearings in a wide range of types and sizes always measure up to high *Hoover Quality* standards.



These seals and O-rings are manufactured by Precision Rubber Products Corporation, Dayton, Ohio, using Hycar rubbers supplied by B.F.Goodrich Chemical Company.

Hycar puts a halter on hydrocarbons ...in seals that take many shapes

Sealing fluids in auto engines, transmissions and power steering assemblies calls for dependable rubber. That's why the manufacturer of these seals and O-rings makes them of rugged Hycar special-purpose rubber.

Hycar nitrile and polyacrylic rubbers are effective in low-swell and high-swell oils, gasoline, fuel oils, hydraulic fluids and sulfur-bearing lubricants. Hycar retains its effectiveness at high or low temperatures.

The wide variety of Hycar rubbers lets you make parts that are effective over a broad range of service conditions. To get more information about how you can use Hycar, write Department MJ-2, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. In Canada: Kitchener, Ontario.

B.F.Goodrich Chemical

a division of The B.F.Goodrich Company

Hycar Rubber and Latex

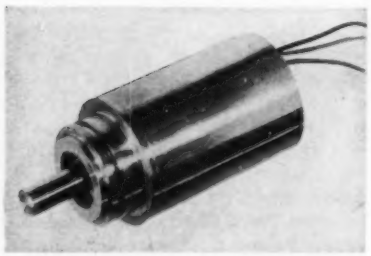
tions; short trip differential of 6°; repeatability of ±0.001 in. at 1⅜ in.; and completely isolated circuits, 1 normally open, 1 normally closed with no common pole. Measures 1 7/16 wide x 3⅞ in. long and can be wired direct without plug-in feature. **R B Denison Mfg Co, 386 Broadway, Bedford, Ohio.**

Circle 311 on Reader Service Card

Aluminum casting process . . .

using 99.9% pure aluminum, produces parts with high electrical and electromechanical characteristics. Rotors can be cast in one step in finished sizes to dimensional tolerances with no machining of end rings, only grinding of OD. This cuts finishing time on 0.250 to 3-in. sizes. There is no pre-heating of laminations to cause loss of electrical characteristics in the semi-cold process. Higher rpm is said to be attained with castings from this process. **Chase Electronics Motor Div Inc, 82-31 51st Ave, Elmhurst 73, NY.**

Circle 312 on Reader Service Card



Angular position transducer

includes transformer and rotary-to-linear converter in same housing. Has temperature range from −65 to 300 F; linearity of ±½%; sensitivity of 5 v full scale; input of 26 v at 400 cps; and phase shift of 3° max with external capacitor. Available with full-scale displacements from ±40° to ±10 revolutions, or more. **Vinson Mfg Co, 8044 Woodley Ave, Van Nuys, Calif.**

Circle 313 on Reader Service Card

Relief-valve cartridge . . .

handling flows up to 40 gpm with very low pressure rise, can be inserted into a simply machined cavity in a multi-valve manifold or body. No cast or machined annuli are required. Valve's differential piston design incorporates a hardened steel, spherically lapped piston mated to a hardened steel, spherically lapped seat. This is said to produce "excellent" repeatability and max life with min leakage. Cartridge is less than 4 in. in over-all length and is made from 1-in. hexagonal steel bar stock.

Available in three adjustment ranges: 200 to 1000 psi; 500 to 2000 psi; and 1000 to 4000 psi. **Fluid Controls Inc, Box 186, Mentor, Ohio.**

Circle 314 on Reader Service Card

Voltage sensing relay . . .

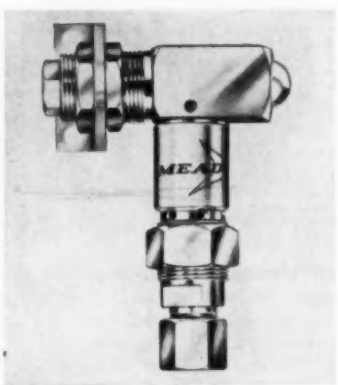
reacts to either ac or dc (depending upon specification) voltage levels and operates relay contacts when a predetermined voltage has been reached. Has input impedance of greater than 100,000 ohms; differential between pull-in and drop-out of less than 1%; switching accuracy of ±5% over temperature range; and adjustability over broad voltage ranges. Available in various contact configurations and ratings to meet individual requirements. **Hi-G Inc, Bradley Field, Windsor Locks, Conn.**

Circle 315 on Reader Service Card

Digital decade display . . .

has lamp driver printed circuit card attached. Each lamp includes one transistor for accepting binary coded decimal inputs and another for amplifying signal to provide correct power for driving. Lamps operate on signal level between 6 and 12 v dc. Unit measures 2⅛ x 1¼ x 9½ in. From stock at $80 each. **Wang Laboratories Inc, Natick, Mass.**

Circle 316 on Reader Service Card



Limit valve . . .

is pneumatic pilot actuator that bleeds only enough air to shift a master valve before closing itself automatically. Bleed duration can be varied to meet circuit requirements that change with distance from master valve, master valve capacity and actuation speed. Flow direction can be changed by another limit valve even while unit remains depressed. **Mead Specialties Co, 4114 N Knox Ave, Chicago 41**

Circle 317 on Reader Service Card

Fluoro-elastomer . . .

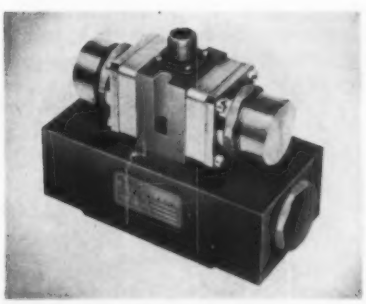
available in tubing, hose and press polished sheets, has max operating temperatures of 400 F in continuous service and 600 F in intermittent use. Temperature brittle point is near −40 F, and hardnesses are from 60 to 95 durometer on Shore A scale. At room temperature, tensile strength ranges from 2000 to 3000 psi and ultimate elongation, from 100% to 400%. Held compressed for 70 hr at 250 F, material recovers to within 90% to 97% of original dimensions. Resistant to corrosive chemicals, fuels and lubricants and produces parts said to have excellent resistance to oxidation and weathering. Die cut and clicked gaskets can be supplied to specifications. **Plastics & Synthetics Div, US Stoneware Co, Akron 9, Ohio.**

Circle 318 on Reader Service Card

Liquid-flow switch . . .

employs a moving Teflon vane in a bronze duct, which, when activated by flow, causes movement of a ceramic permanent magnet, which, in turn, creates a rotary force to actuate a snap action switch. Has max current capacity of 5 amp, 250 v ac, and is available in ranges of ½ to 6 gpm. Protects fluid-cooled electronic and electrical equipment; guards against failure of lubricating systems; prevents damage to fluid-cooled welding machines, air compressors, condensers, humidifiers, etc; and operates appliances such as pumps. Measures 3⅜ x 2¼ x 1½ in. and is furnished with ⅜-in. IPS female pipe threads. **Henry G Dietz Co Inc, 12-16 Astoria Blvd, Long Island City 2, NY.**

Circle 319 on Reader Service Card



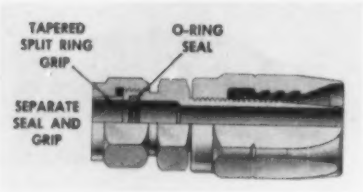
Dual-voltage valve . . .

operates on both 115 v ac and 28 v dc without adjustment or coil changes. Uses regular 60-c line current, but can be sup-

continued on page 66

plied for 400 c ac. Assembly includes solenoid-operated pilot valve and heavy duty slave valve. Various flow sizes are available, depending upon slave unit specified. All components are for nominal system pressures to 5000 psi and have life expectancy of more than 5 million cycles. Offers pressure operation to all positions, which is said to overcome contamination hangups encountered with standard spring returns. Has no moving seals. Coil operates on either voltage with less than 0.5-amp current drain and temperature rise of less than 100 F. **Parker Aircraft Co, 5827 W Century Blvd, Los Angeles.**

Circle 320 on Reader Service Card



Tube-to-hose fitting . . .

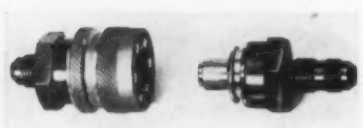
with separate grip and seal joins tube to one end of hose assembly without an adapter. Eliminates need for female swivel or any threading, flaring or soldering of tubes or pipes. Tube need not be cut straight or to exact length. Reusable fitting gives tube added support and is unaffected by vibration. Ranges in hose ID size from $\frac{3}{16}$ to $1\frac{1}{2}$ in. and tube OD size from $\frac{1}{4}$ to $1\frac{1}{2}$ in. **Lenz Co, 3301 Klepinger Rd, Dayton 1, Ohio.**

Circle 321 on Reader Service Card

Spiral-wrap hose . . .

is suitable for hydraulic systems requiring $1\frac{1}{4}$ to 2-in. hose sizes with working pressures up to 3000 psi. Hose has synthetic inner tube with alternating layers of spiral wire wrapping and synthetic rubber. Segmented fittings, which can be assembled with simple hand tools, are leakproof and blowoff proof. Hose need not be skived to attach fittings. **Aeroquip Corp, Jackson, Mich.**

Circle 322 on Reader Service Card



Quick-connects . . .

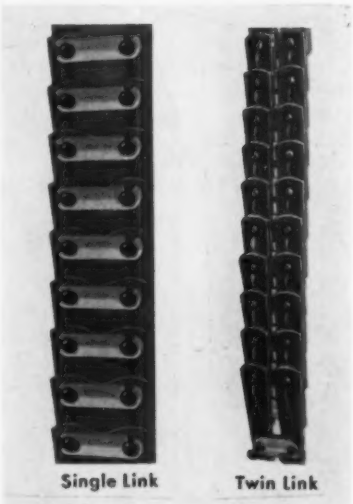
sustain operating pressures up to 3000 psi and withstand vibrations of 20 g's at 2000 cps. Disconnect under 3000-psi pressure and connect under 50-psi pressure. Entry seal on each coupling prevents leakage during connection. Axial dog latching mechanism permits breakaway action for staging and panel applications. Eight models are available in stainless steel or aluminum and in sizes from $\frac{1}{4}$ to 2 in. ID. **Wiggins Connectors, 3424 E Olympic Blvd, Los Angeles 23.**

Circle 323 on Reader Service Card

Miniature filler valve . . .

operates at pressures from 0-200 psig and temperatures from −420 to 260 F. Does not leak while halves are disconnected, or during fill operation. Female portion weighs 4 oz, including dust cover, while male half weighs 2 oz with cover. Ground (female) half includes insulating sleeve and annular air space as a thermal barrier. Available in wide range of fittings with delivery in 30 days. **Airborne Research & Development Corp, 7530 San Fernando Rd, Sun Valley, Calif.**

Circle 324 on Reader Service Card



Variable-speed belting . . .

in single or twin link form is quickly adjusted to any required length. Widths are from $\frac{7}{8}$ to 4 in. Fits all V-to-V drives and is interchangeable with all endless moulded and wood block belts. Installed or detached with pliers and hook tool, and flexes easily around small diameter pulleys. Available by the foot. **Lovejoy Flexible Coupling Co, Dept PE-1, 4856 W Lake St, Chicago 44.**

Circle 325 on Reader Service Card

Shaded-pole induction motors

have die-cast bearing brackets with projections anchored in field laminations. As a result, rotor alignment is maintained under heavy shock. Used alone or with geared motors, units are available in 4-stack thicknesses from 0.35 to 1.1 in. and max continuous duty torque ratings from 0.8 to 3 in.-oz at 120 v (1.3 to 11.5 in.-oz during intermittent duty). No load speed is approx 3350 rpm. **Brevel Products Corp, 601 W 26th St, New York 1.**

Circle 326 on Reader Service Card

Cold-cathode trigger tube . . .

is subminiature, gas-filled unit equipped with two starters for use in forward-backward counters, gates and reset applications. When used to reset, no additional tube is required. To obtain short ignition delay, tube has priming cathode. Can be used in counters with frequency up to 5 kc. Starter current is 30 microamp. Designed for dc circuits, it reportedly will last for over 30,000 hr operation and is independent of lighting conditions, glowing bright red when ignited. **Amperex Electronic Corp, Semiconductor & Special Purpose Tube Div, 230 Duffy Ave, Hicksville, LI, NY.**

Circle 327 on Reader Service Card

Transparent butyrate tubing

is available in 76 sizes from 0.750-in. OD with $\frac{1}{16}$-in. thick wall to 6.625-in. OD with $\frac{1}{4}$-in. thick wall. Has impact strength of 2 ft-lb per in. of notch at 73.4 F and only 0.9 ft-lb at −40 F. Tensile, flexural and compressive strengths are reportedly high for its low specific gravity of 1.2. Can be drilled, sawed tapped, lathe-turned and cut. **Busada Mfg Corp, 32-21 Downing St, Flushing 54, NY.**

Circle 328 on Reader Service Card

Size 11 magnetic clutch . . .

and spring-centering mechanism are coupled to a center-tapped potentiometer. When energized, clutch engages potenti-

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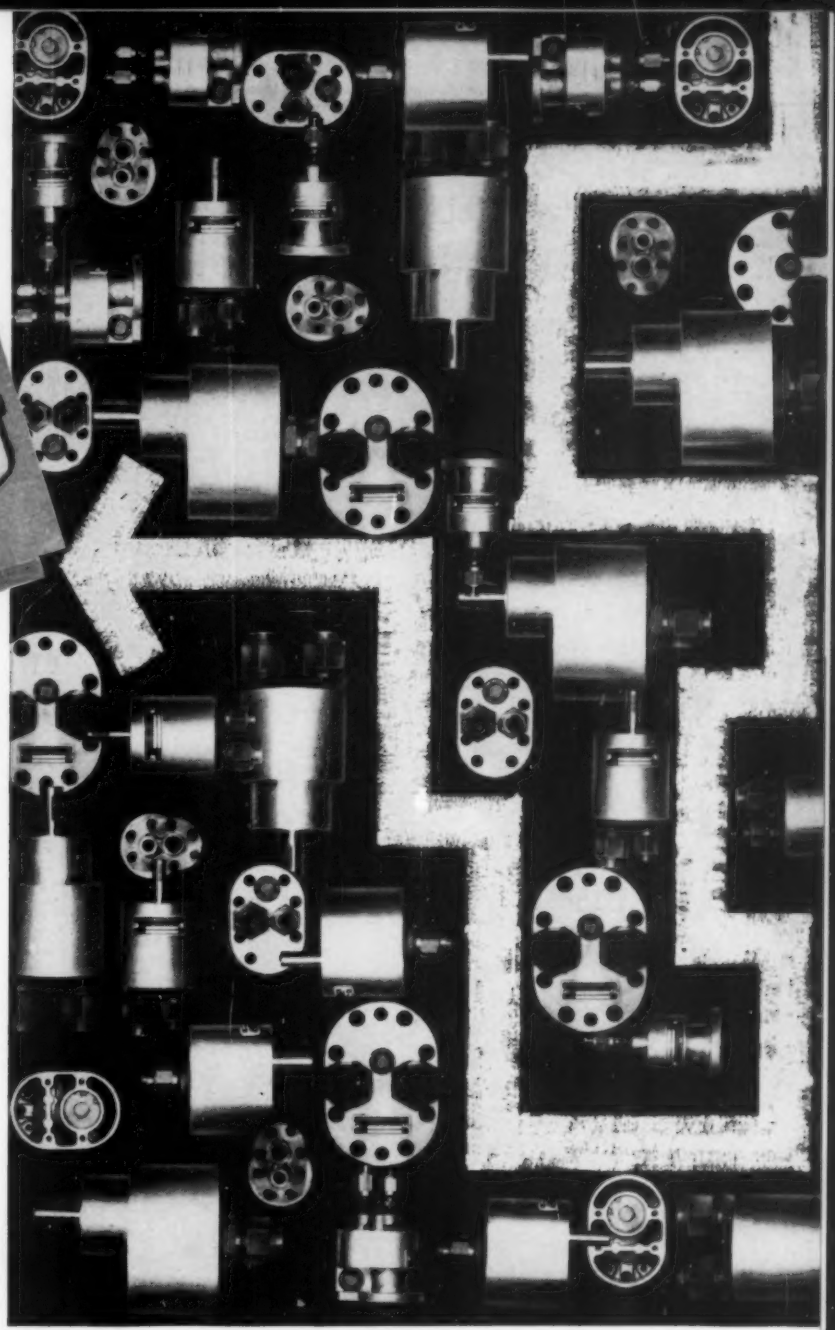
CIRCLE 67 ON READER SERVICE CARD→

your guide to *the gear pump* for your application



This new catalog is an invaluable directory to no less than 129 pump-and-electric-motor-combinations — any and all available off-the-shelf!

Searching for gear pumps with top volumetric efficiencies? Do your performance requirements fall into one of these three major groups?

- Eastern 1200 series — up to 1.6 gpm — pressures to 800 psi
- Eastern 100 series — up to 5 gpm — pressures up to 1500 psi
- Eastern 700 series — up to 9.8 gpm — pressures up to 1500 psi

If one or more of these performance ranges measures up to what you need, save hours of searching your way through the gear pump maze — send for catalog 810 now!

Other Eastern products:

- **hydraulic motors**
- **positive displacement pumps**
- **centrifugal pumps**
- **aircraft pumps**

EASTERN INDUSTRIES, PUMP DIVISION

EASTERN INDUSTRIES, INCORPORATED

Hamden, Connecticut

BLH ADVANCES THE STRAIN GAGE ART WITH NEW WELDABLE, PRE-STABILIZED GAGES THAT INSTALL IN MINUTES

For the first time, strain gages that are both easily weldable and electrically stable from cryogenic through 750°F temperatures.

New BLH Weldable Strain Gages incorporate special SR-4® foil gages bonded to stainless steel shim stock .005 in. thick which can be matched to the coefficient of the test material. This new development enables gages to be closer to the test surface, improves conformity with the surface, and eliminates local buckling.

No curing needed after installation, because the gages are fully stabilized by heat treating. They offer high linearity of strain response in either tension or compression and operate in a strain range of ±0.5%.

Two types available—a phenolic-bonded Constantan foil for temperatures to 500°F, and a ceramic-bonded Nichrome V foil for temperatures to 750°F and higher. Temperature compensation is available to ±1 ppm/°F for units utilizing Constantan foil.

Wide range of applications is seen for testing nuclear reactor power loops, liquefied gas pressure vessels and systems, rocket and missile components and engines, and wind tunnel and shock chamber testing of aircraft parts.

Available locally through 16 BLH sales engineering representatives in the U.S. and Canada. For detailed information or assistance, contact the one nearest you—or us here in Waltham.

BALDWIN • LIMA • HAMILTON
Electronics & Instrumentation Division
Waltham 54, Mass.

FIRST in force measurement

SR-4® Strain Gages • Transducers • Temperature Sensors • Systems

ometer for continuous rotation in either direction. Clutch disengages when de-energized, and spring centering mechanism returns potentiometer shaft to ±15 min of pot center-tapped position. Return time is under ½ sec (faster returns can be obtained). Operating life is 1000 hr; weight, 3.5 oz. Clutch characteristics are 28 v dc; 8 in.-oz torque min; 3 w; 12 millisec response time. Coupled single turn, servo-mounted, ballbearing pot can have any characteristics, accuracies or sizes. Rear shaft extension also can be provided for driving dial, counter or other gear mechanisms. **Orbit Instrument Corp, 131 Eileen Way, Syosset, LI, NY**

Circle 329 on Reader Service Card

Moistureproof thermostat . . .

is enclosed in polypropylene boot filled with epoxy resin. Also resists dust and fumes. Bimetal disk thermal element is located close to aluminum or tin-plated brass sensor cap, providing rapid response to temperature changes. Disk also prolongs thermostat life by minimizing arcing and eliminating chattering and false cycling. Rated for 100,000 cycles up to max operating temperature of 176 F. Electrical ratings are 15 amp resistive, 5.2 amp FLA and 31.2 amp LRA at 120 v ac; half these at 240 v ac. Pilot duty rating is 125 va for 129-240 v ac. Typical ranges are −20 to 79 F and 80 to 176 F; tolerances, ±6 F and ±5 F, respectively, on open and close, and mean differential, 15/19 F. **Stevens Mfg Co Inc, PO Box 1007, Mansfield, Ohio.**

Circle 330 on Reader Service Card

High-voltage potentiometer . . .

is available in both 2500- and 3000-v ratings with power-dissipation capabilities of 2 w. Insulated bushing and shaft is equipment on 3000-v unit. Has rotational life of 100,000 cycles and operates in ambients from −67 to 257 F. Composition-molded resistive element permits below standard noise level; elimination of hot spots; long life; and high resistance to moisture. **Reon Resistor Corp, 155 Saw Mill River Rd, Yonkers, NY**

Circle 331 on Reader Service Card

Four-layer diode . . .

in subminiature "glass" package, handles 10-amp pulses or 150-milliamp continuous current—said to be three times capacity of comparable units. Essentially a fast pnpn, two terminal, silicon switch with two stable states: OFF, or high impedance, and ON, or low impedance. Actuates self

continued on page 70

NEW FAST DRAW TECHNIQUE CUTS FABRICATING COST OF MAGNESIUM

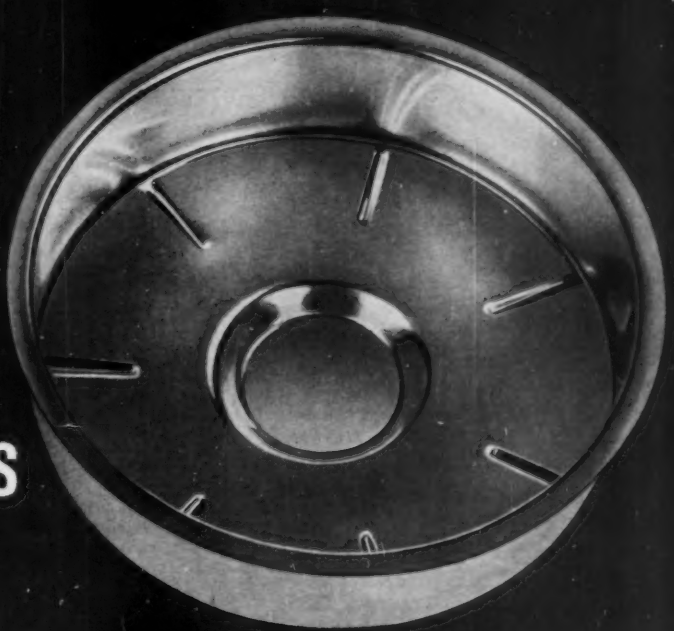
Magnesium parts are now being deep-drawn experimentally at high speeds with a newly-developed process. It uses standard mechanical presses, moderate temperatures (400°F.) and ordinary soap-type lubricants. The part illustrated below was drawn and ejected in 1½ seconds.

This technique cuts the cost of fabricating cylindrical parts of magnesium—with its unparalleled combination of light weight, stiffness and strength. Draws to a 50% reduction are made readily at normal production speeds with a minimum of die stages.

The new technique is expected to find use for many drawn magnesium parts, including components of appliances and business machines. Find out what it can do for you. Write THE DOW METAL PRODUCTS COMPANY, Midland, Mich., Merchandising Dept. 1109DZ5-22.

FROM BLANK...

TO PART...

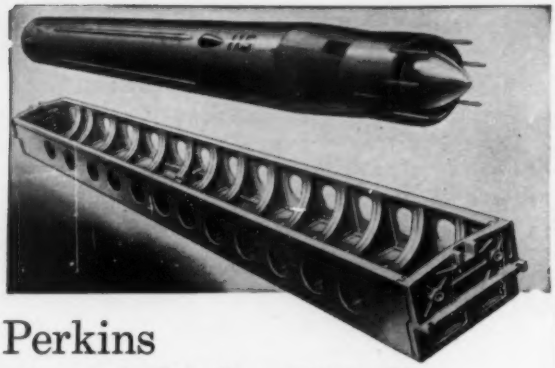


IN 1½ SECONDS CYCLE TIME

DOW **THE DOW METAL PRODUCTS COMPANY**

Division of The Dow Chemical Company

CIRCLE 69 ON READER SERVICE CARD



Missile tray made by Brooks & Perkins *beats target weight by 300 lbs.*

Air transported missiles require minimum weight handling equipment so that important defense weapons can be moved efficiently and on schedule. Recently, Brooks & Perkins was given the responsibility for engineering, designing, building the prototype and manufacturing an aluminum missile tray, shown above.

Unusual loading problems and the extreme importance of deflection required a dimensional tolerance of ± 1/32" in the 33-foot over-all length at 68°F. B & P not only met all tolerance requirements, but also reduced the initial target weight by 300 lbs.

The aluminum missile tray is another example of Brooks & Perkins skill and experience in the fabrication of light metal products for ground support equipment.

For more information and details of this and other GSE programs, write direct to Brooks & Perkins, Detroit.

BROOKS & PERKINS, Inc.
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Gear Applications

Broached brush holders hold close tolerances for brush alignment, to give increased brush life! Self-aligning sleeve-type bearings with finger-type pressure plates for uniform alignment and extra-heavy stamped steel housing assure smooth performance. Won't stall even with heavy jarring!

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Divisions: (EMC) Electric Motor Corp. (CS) Cyclohm Motor Corp. (LS) Loyd Scruggs Co.

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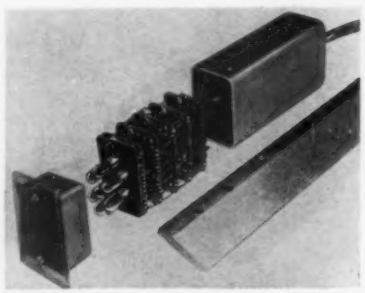
and is turned off by reducing current to below holding current. Turn-on time, depending on circuit, is less than 0.1 microsec. Dissipates more heat and is stable over —76 to 257 F range. Measures 0.280 in. long, weighs 2 grams and is available in commercial and military types with switching voltage ranges from 20 to 200 v. **Shockley Transistor, Unit of Clevite Transistor, Stanford Industrial Park, Palo Alto, Calif.**

Circle 332 on Reader Service Card

Teflon hose . . .

in -16 size (nominal 1-in. ID), is rated 3000-psi working pressure for both fluid and ambient temperatures from —65 to 400 F. Tested to 250,000 impulse cycles at min bend radius and with impulse pressure peaks of 4500 psi. Inner tube is reinforced with bonded multiple-spiral wraps of wire and an outer braid. Entire construction designed for high impulse rating with low weight and tight bend radii. Min bend radius is 9⅜ in. Available with high-pressure swaged fittings. **Resistoflex Corp, Roseland, NJ.**

Circle 333 on Reader Service Card



Miniature decade counter . . .

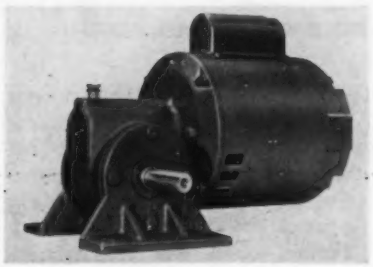
uses tungsten lamps for bright in-plane display; modular printed circuit boards; and computer-type transistors. Boards can be opened for servicing by removing two strut screws. Grounding one of two control lines reverses count direction. Operating voltage is 24 to 30 v. **Robotomics Corp, 2422 E Indian School Rd, Phoenix 16, Ariz.**

Circle 334 on Reader Service Card

Right-angle gearmotors . . .

available in ⅛-, ⅙-, ¼- and ½-hp ratings, are smaller over-all and weigh less than previous models (for example, ¼-hp unit has been reduced in weight from 46 to 26 lb). Have reversible output shafts, allowing user to transfer shaft to right or left-hand side of gear unit in the field. Thirteen standard reduction ratios are offered, and enclosures

continued on page 71



include dripproof, totally enclosed and fan-cooled. **Reliance Electric & Engineering Co, 24701 Euclid Ave, Cleveland 17.**

Circle 335 on Reader Service Card

Backup alarm . . .

automatically sounds intermittent warning signal whenever equipment controls are in reverse. Signal pitch is above level of normal background noise, and volume is adjustable. Unit consists of heavy cast aluminum loudspeaker with integral housing containing transistor-equipped tone oscillator which operates from 6-, 12- or 24-v-ac power source. Assembly is weatherproof. **Femco Inc, Irwin, Penna.**

Circle 336 on Reader Service Card

Circuit overload protector . . .

is an ac-sensitive device accurate to within 5% and independent of ambient temperature. Described as "not a magnetic switch nor a conventional thermal device." Trip-out point is delayed to permit motor starting and is varied over current range from a fraction to several hundred amps. Said to be quickly responsive to single phasing failure in motors and also can monitor temperature of motor field. Fast trip-out just above locked rotor current is provided for short circuit protection. Powered solely by load current and does not use transistors. **Mecca Cable & Service Inc, Rt 4, Box 651, Houston, Tex.**

Circle 337 on Reader Service Card

Positioning fixture . . .

consists of from 1 to 3 arms mounted on a 1-ft upright. Each arm ends in a machinist's clamp that can be adjusted to any position and tightened by a single knob to hold weights up to 10 lb. Arms and cross-pieces permit components to be positioned in any three-dimensional relationship to one another, and also allows whole assembly to be rotated about any of three axes. Max spread of arms is 2½ ft. Clamps at arm ends open to 1¼ in. max. From stock at $65 for 2-arm units and $89 for 3-arm unit. **Norman Epstein, RD 2, Carmel, NY.**

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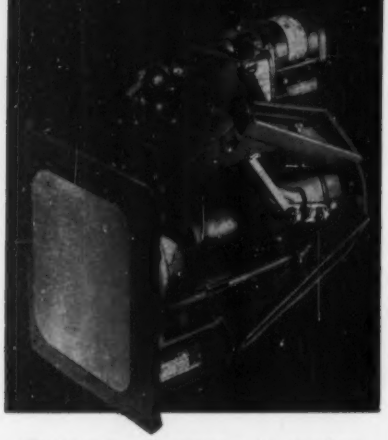

This ram air scoop is another example of AiResearch's ability to design and integrate structural and electromechanical systems for control functions.

Through its use, air is provided for emergency cabin pressurization and the cooling of electronic components. The unit is composed of a retractable aluminum ram air scoop, extended and withdrawn by a 400 cycle rotary actuator, a self-contained 350 watt heating element and an integral check valve.

The most experienced company in the development and production of control systems for airborne and ground use, AiResearch has the ideal facilities and know-how to handle problems concerning electromechanical systems and components of all types for aircraft, ground handling, ground support and missile systems.

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AiResearch Manufacturing Division

Los Angeles 45, California

DESIGN LITERATURE

Thermoelectricity

DR J W DAVISSON AND JOSEPH PASTERNAK. Office of Technical Services, PB 161977, US Department of Commerce, Washington 25, DC. 8 x 10½. 61 p. $1.75.

For those studying or working with thermoelectric devices, this survey ("Status Report on Thermoelectricity") will be extremely valuable. It has several excellent charts and tables, giving Seebeck coefficients, resistivity, and other pertinent data on more than a score of potentially useful materials.

Minerals Economics

ORRIS C HERFINDAHL. Resources for the Future Inc, 1775 Massachusetts Ave, NW, Washington 6, DC. 6 x 9, 63. $1.

If you're planning for the long pull, this little volume will provide a survey of trades in metals prices—past, present, and possible future. It's a good followup to the famous Presidential Report on Materials Policy.

Data Services for the Defense Industry

Two new services are designed to give defense industry subscribers answers to such questions as: "Who in government is awarding what defense contracts?"; "Who is getting them?"; "Are we getting our share?"; "Where should we focus sales and engineering effort?"

The first of these services, "The Defense Sales Director," will bring to subscribers every two weeks information on contracts awarded by every government agency to every prime contractor, and from significant prime contractors to subcontractors.

The second service, "Defense Market Measures," is a statistical and analytical quarterly review of the defense industry broken down in two ways: by 150 categories of defense products, and by 1500 prime contractors. The data in this service promises to show for the current quarter, the year to date, and the previous year, the amounts awarded to each prime contractor, the government agency that made the award and the product category in which it was made. Or, broken down by product category, it will show dollars awarded in missile solid propulsion, electronic switching, antisubmarine devices and the 147 other categories, as well as the awarding agency, and the company receiving the award.

Further information on these services may be obtained from Frost & Sullivan Inc, 170 Broadway, New York 38.

Complex Variables and the Laplace Transform for Engineers

WILBUR R LEPAGE. McGraw-Hill Book Co Inc, 330 W 42nd St, NY 36. 6¼ x 9¼, 475 pp. $12.50.

Written at a graduate level, this new work lays the mathematical foundation for a broad area of engineering analysis, covering the topics of complex-variable theory, the Fourier and Laplace transforms, convolution integrals, and the theory of application of these topics to the solution of linear integrodifferential equations. The author includes an extensive philosophical discussion of impulse functions.

Emphasis is placed on interpretation of mathematical ideas of importance in engineering applications. In this respect it differs from rigorous works by pure mathematicians, which often are too general for the engineer, and from typical applied books for engineers which tend to ignore important mathematical concepts.

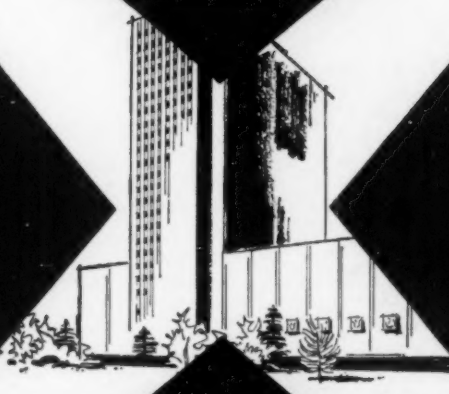
Environmental Effects on Materials and Equipment

7 x 10, 36 pp.

A new monthly abstracts journal published by the National Academy of Sciences, 2101 Constitution Ave, Washington 25, DC, is intended to aid design engineers, materials specialists, specification writers and evaluators, test personnel, research directors, and others who are charged with responsibility for guaranteeing reliability, operability, and durability of military and other material in all environmental conditions of transportation,

continued on page 75

COME SEE WHAT'S NEW IN PLASTICS



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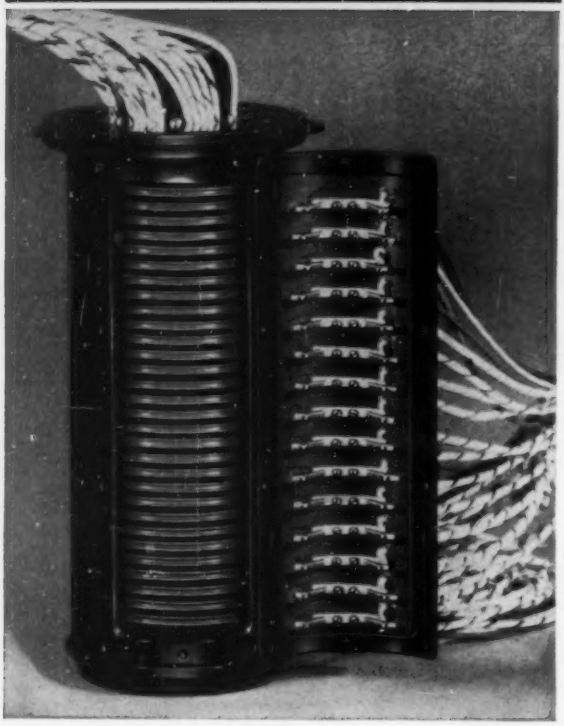

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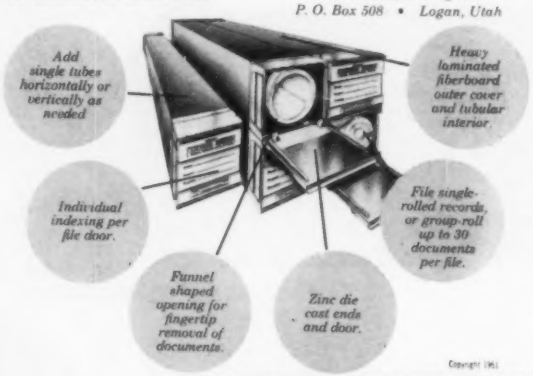
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storage, and use. The field to be emphasized in this new publication is that variously referred to as the "induced," "hyper," or "space-associated" environment and includes effects of such factors, or combinations of factors, as shock, vibration, excessive heat, vacuum, gravity, magnetism, electromagnetic radiation, dissociated and ionized gages, meteoritic dust, aurorae and coronae. Subscriptions are available at $25 a year.

Metals Engineering Quarterly

This new quarterly published by the American Society for Metals, Metals Park (Novelty), Ohio, will include outstanding presentations made at the technical sessions of the annual National Metal Congress and the several ASM chapter-sponsored regional conferences throughout the United States. Will be issued in Feb, May, Aug and Nov of each year, and available to ASM members at $6 yearly, nonmembers $10.

ABSTRACTS FROM THE LITERATURE

Process Control Terms

Provides a guide for understanding the terms used in process control theory and instrumentation.

"Can You Define Process Control Terms?" R. Horney, Ryerson Institute. Design Engineering, Apr '61, 481 University Ave, Toronto 2, Canada.

Free Engineering Advice

Describes advantages and disadvantages of engineering services provided by suppliers.

"Free Engineering Costs You Money," Walter Erwin, Metal Atomizing Corp, Design Engineering, Mar '61, 481 University Ave, Toronto 2, Canada.

Corrosion Design Problems

Explains importance of communications between corrosion engineers and design personnel so that possible corrosion problems can be foreseen and minimized during the design stages of chemical process equipment. Presents four corrosion-data sheets as suggested means of obtaining information necessary to the corrosion engineer. Basic data sheet is given plus examples for heat-transfer equipment, pumps and pressure vessels. Also explains that data collected for these sheets would not be more than is usually required for design specifications. Emphasizes importance of involving corrosion personnel during the design states of equipment.

"Corrosion Design Problems in Chemical Process Equipment," Ira C Bechtold, Corrosion, Mar '61, 1061 M & M Building, Houston 2, Texas.

Porosity of Electrodeposits

As the cavities encountered in electrodeposits may belong to quite different types, a system of classification and symbols is suggested to avoid misunderstandings. The system is based on distinguishing between pores and cracks, on whether they extend from the basis metal to the surface of the deposit or are bridged, and on their size. The transverse and masked cavities are further divided into several types. The different causes of porosity are reviewed and the faults arising are classified. The principal methods of assessing porosity are also briefly discussed.

"The Porosity of Electrodeposits, Causes, Classification and Assessment," Artur Kutzelnigg, Siemens, Schuckert Werke, AG, Laboratories of the Central Works Department, Erlangen, Germany. Plating, Apr, '61, 443-445 Broad Street, Newark 2, NJ.

Mold Design for Plastics

Discusses fundamentals of good mold-design practice.

"The Importance of Good Fundamental Mold Design," C E Ballentine, Scripto, Inc. SPE Journal, Mar, '61, 215 Canal St, Manchester, NH.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

SELF-LOCKING NUTS—Catalog 114, aprox 156 pp. Contains dimensions, specifications, dimensional drawings and photos of full line of lightweight, all-metal nuts, including floating and nonfloating stakenuts in regular and miniature sizes and high-strength, thin-wall inserts. Locking principle and other features are discussed, and weight savings, compared with competitive parts, are tabulated. Kaylock Div, Kaynar Mfg Co Inc, Box 2001, Terminal Annex, Los Angeles 54.

Circle 340 on Reader Service Card

BALL VALVES—Catalog 1200, 32 pp. Dimensions and weights, material specifications, typical C_v values and pressure-temperature rating charts are provided for pneumatically operated ball valves in sizes from ¼ to 12 in. Schematics show design features and operation, and tables trace suitability of standard body materials and various seat materials for wide range of chemical services. Hills-McCanna Co, 400 Maple Ave, Carpentersville, Ill.

Circle 341 on Reader Service Card

ADHESIVES, COATINGS, SEALERS—Catalog, 54 pp. Lists, in numerical form, military specifications, specification definitions, intended application and adhesive, coating or sealer that meets these specifications. Adhesives, Coatings and Sealers Div, Minnesota Mining & Mfg Co, 900 Bush Ave, St. Paul 6.

Circle 342 on Reader Service Card

SILICONES—Catalog CDS-129C, 8 pp. Details performance of various silicone products and includes complete property table on silicone rubber. In addition to rubber, deals with silicone fluids, protective coatings, and electrical insulation. General Electric Co, Silicone Products Dept, Waterford, NY.

Circle 343 on Reader Service Card

UNIVERSAL JOINTS—Brochure, 8 pp. Explores use of roller bearing universal joints in such applications as aircraft drive shafts, controls, power torque systems, tail rotor drives, etc., and illustrates approx 15 assemblies with dimensional drawings. Loading and speeds are discussed. Mechanics Universal Joint Div, Borg-Warner, 2028 Harrrison Ave, Rockford, Ill.

Circle 344 on Reader Service Card

HEAVY-DUTY TRANSMISSIONS—Brochure, 8 pp. Supplies specifications and typical application photos of 13 models. Transmission variables, such as rotation, speeds, shifting, cooling, etc., are discussed and illustrated. Cotta Transmission Co, 2300 11th St, Rockford, Ill.

Circle 345 on Reader Service Card

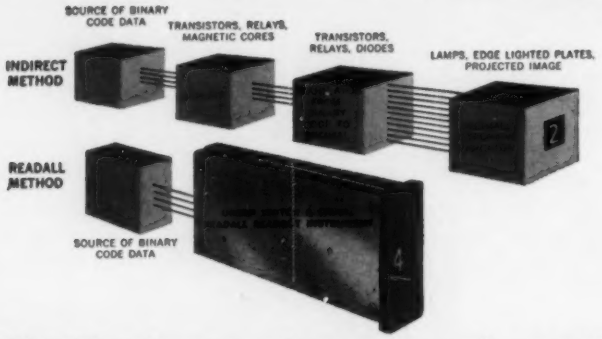
DIAPHRAGMS AND ASSEMBLIES—Brochure DI-100, 4 pp. Explains manufacture of elastomer fabric diaphragms, types available for both static and dynamic applications, and sidewall thicknesses and flange configurations that can be specified. Also discusses complete assemblies to include actuators, controls, accumulators, transducers, positioners and motion-transmission devices. Diaphragm Industries Inc, Beverly, Mass.

Circle 346 on Reader Service Card

AC MOTORS—Bulletin B-2515, 16 pp. Outlines product features and specifications of units from 1 to 2000 hp. Cutaways

continued on page 76

READALL READOUT NEWS from Union Switch & Signal



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and production line photos are included. Reliance Electric & Engineering Co, Cleveland 17.

Circle 347 on Reader Service Card

EXPANDED METALS—Catalog 61, 23 pp. Illustrates decorative expanded metal designs and commercial meshes and gratings and gives their weights, dimensions, percentages of open area and available materials. Also discusses fabrication processes. Designers Metal Div, Southern Electric Inc, 8701 S Greenwood Ave, Chicago 19.

Circle 348 on Reader Service Card

FLEXIBLE COUPLINGS—Bulletin J-23, 4 pp. Carries outline drawings and specifications of power drive couplings, including double and single engagement, mill motor, extended, standard mill, etc. Jones Machinery Div, Hewitt-Robins Inc, Dept FC, Stamford, Conn.

Circle 349 on Reader Service Card

AIR CYLINDERS—Bulletin A-101, 12 pp. Mounting dimensions and diagrams are offered for 1¼ to 14-in. bore sizes, and data on cylinder action, rods, ports, seals, cushions and piping is outlined. Large cutaways pinpoint design features. Milwaukee Cylinder Co, 5757 S Pennsylvania Ave, Cudahy, Wis.

Circle 350 on Reader Service Card

LIQUID-LEVEL GAGE VALVES—Catalogues 397, 398, 4 pp. each. Describe and illustrate features, styles, sizes and construction details of union bonnet and screwed bonnet units. Included are roughing drawings and tables of standard and optional features. Jerguson Gage & Valve Co, 80 Adams St, Burlington, Mass.

Circle 351 on Reader Service Card

LEATHER PACKINGS—Brochure, 6 pp. Covers diameters, prices and discount information on V- and U-packings, cups, flanges, disks and washers supplied in any of three leather tannages—oak, chrome and chrome retan leather. Auburn Mfg Co, 306 Stack St, Middletown, Conn.

Circle 352 on Reader Service Card

TORQUE MOTORS—Bulletin 208A, 4 pp. Contains speed-torque curves, duty specifications, dimensions and lists wide range of ratings. Outline drawings are supplied. Ohio Electric Mfg Co, Sub of Howell Electric Motors Co, Maple Heights, Ohio.

Circle 353 on Reader Service Card

CLOSED-CELL SEALING MATERIALS—Catalogs E-60 and CS-160, 8 and 4 pp. Former, dealing with closed cell rubber extrusions, carries typical cross section illustrations and physical and thermal properties. Latter, covering Neoprene

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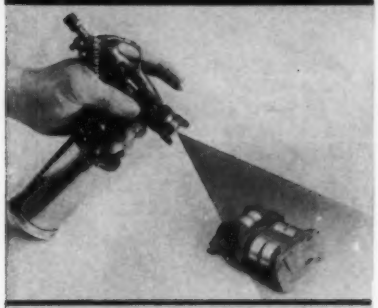
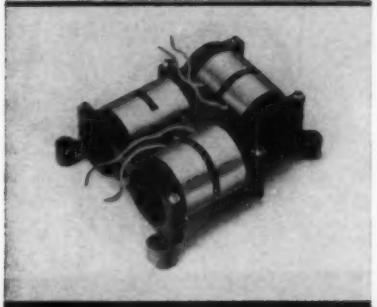
Electrofilm





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closure strips, illustrates shapes and supplies data on pitch, depth, length, width and valley of each. Rubatex, Div of Great American Industries Inc, Bedford, Va.

Circle 354 on Reader Service Card

STRIP HEATERS—Catalog C-300, 12 pp. Supplies high and low temperature ratings, wattages, voltages and dimensions of units with both terminals at one end and those with one terminal at each end. Series of tables gives average specific heats and other physical characteristics of various common solids, liquids, gases and vapors. Curves illustrate factors to be considered in selecting strip heaters. Bryant Electric Co, Box D, Barnum Station, Bridgeport 2, Conn.

Circle 355 on Reader Service Card

COATINGS—Folder 4071, 4 pp. Describes 18 wax emulsions, resin emulsions, solvent-base waxes and self-polishing solvent-base waxes and resins used for product protection and appearance, mold or die release and dry lubrication. Includes data on methods of application, coverage, drying time and uses on such materials as metals, leather, paper, plastic, rubber, wood, etc. Service Products Div, Johnson's Wax, Racine, Wis.

Circle 356 on Reader Service Card

LOGIC PANELS—Brochure, 4 pp. Describes and illustrates units, which contain 200-kc digital circuit modules, and their use in logic breadboarding, small system construction, programmable test, control and timing equipment, etc. Power requirements are tabulated. Epsco Components, Div of Epsco Inc, 275 Massachusetts Ave, Cambridge 39, Mass.

Circle 357 on Reader Service Card

LOW-POWER TUBES—Brochure, 8 pp. Tabulates specifications of low-power transmitting tubes, series regulators, rectifiers and clipper tubes. Diagrams each tube's base and envelope connections and discusses military specifications and quality control techniques. Raytheon Co, Industrial Components Div, 55 Chapel St, Newton 58, Mass.

Circle 358 on Reader Service Card

SEMICONDUCTORS—Brochure, 16 pp. Lists mechanical construction and electrical ratings of transistors, diodes, rectifiers and microwave diodes, including epitaxial silicon and germanium transistors and epitaxial varactor diodes. Sylvania Electric Products Inc, 1100 Main St, Buffalo 9, NY.

Circle 359 on Reader Service Card

PREALLOYED POWDERS—Brochure 128, 4 pp. Covers advantages, availability and characteristics of prealloyed stainless

continued on page 79

NEW O-M AIR CYLINDER

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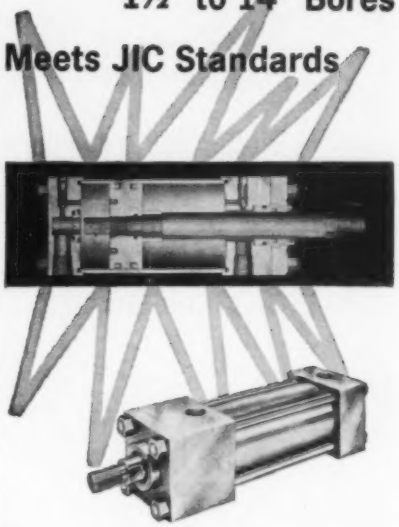

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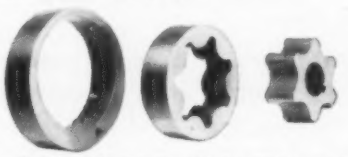

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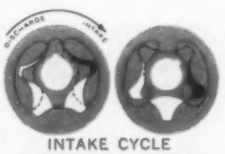

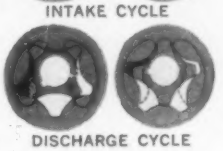

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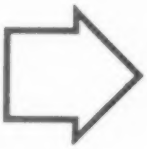

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365—Time Switches, 2 pp, Tork Time Controls Inc.

HYDRAULIC, PNEUMATIC EQUIPMENT

341—Ball Valves, 32 pp, Hills-McCanna Co.
350—Air Cylinders, 12 pp, Milwaukee Cylinder Co.
351—Liquid Level Gage Valves, 4 pp, Jerguson Gage & Valve Co.
352—Leather Packings, 6 pp, Auburn Mfg Co.
366—Power Cylinder Accessories, 2 pp, Hanniffin Co.

(please print or type) *If this is change of address, check box* ☐

Name ..... Title .....

Street .....

City ..... Zone ..... State .....

Company ..... Major Product Manufactured .....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS

583	584	585	586	587	588	589	590	591	592	593	594
595	596	597	598	599	600	601	602	603	604	605	606

*MULTIPLE PRODUCT ADS

Key No.	Specific Product

(please print or type) *If this is change of address, check box* ☐

Name ..... Title .....

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17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
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583	584	585	586	587	588	589	590	591	592	593	594
595	596	597	598	599	600	601	602	603	604	605	606

*MULTIPLE PRODUCT ADS

Key No.	Specific Product

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Issue of May 22, 1961
PRODUCT ENGINEERING
Card expires July 21, 1961

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

Postage Will Be Paid By Reader Service Department

Inquiries Services Department
PRODUCT ENGINEERING
P.O. Box 601
Ridgefield, Connecticut

Issue of May 22, 1961
PRODUCT ENGINEERING
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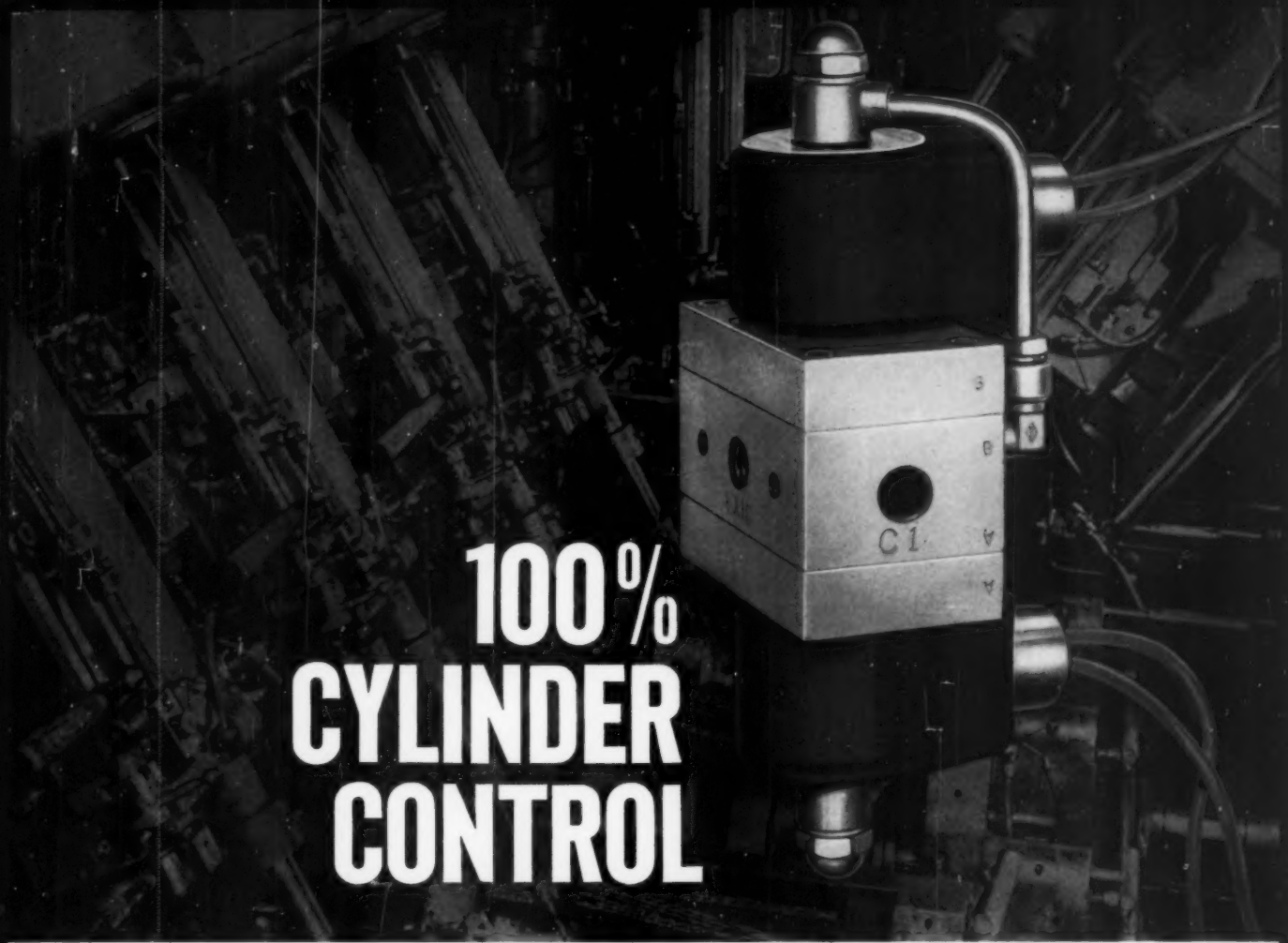


100% CYLINDER CONTROL

DEAD-TIGHT SEATING OF ASCO 4-WAY SOLENOID VALVE PREVENTS PISTON DRIFT ...PERMITS PRECISION INCHING

3-POSITION, 4-WAY DESIGN

POPPET-TYPE SEATING— CANNOT STICK OR LEAK

INSTANTANEOUS OPERATION

EXPLOSION-PROOF ENCLOSURE AVAILABLE

PRESSURES UP TO 250 PSI ON AIR, WATER OR OIL

RUGGED BRASS BAR STOCK

2 SOLENOID CORES AND 4 DIAPHRAGMS ARE ONLY MOVING PARTS

Positive control of the cylinder piston is inherent in the design of this ASCO Bulletin 8347 valve. Leakage of air or liquid is made impossible, so that whenever both solenoids are de-energized, the valve assumes a center position and all orifices are blocked, locking cylinder piston in position. Dead-tight (poppet-type) valve seating permits precision inching of the piston, as well as absolute control of any length of stroke, with instantaneous stopping and not a trace of drift.

The utter simplicity of design and rugged construction assure many millions of trouble-free operations. You can choose the 8347 in either the ¼" or the ⅜" pipe size for pressures to 250 psi, and you can mount it in any position. It is available from stock for immediate delivery, as are other ASCO solenoid valves.

Write for Bulletin 8347, providing complete descriptive information on this new, reliable 4-way.

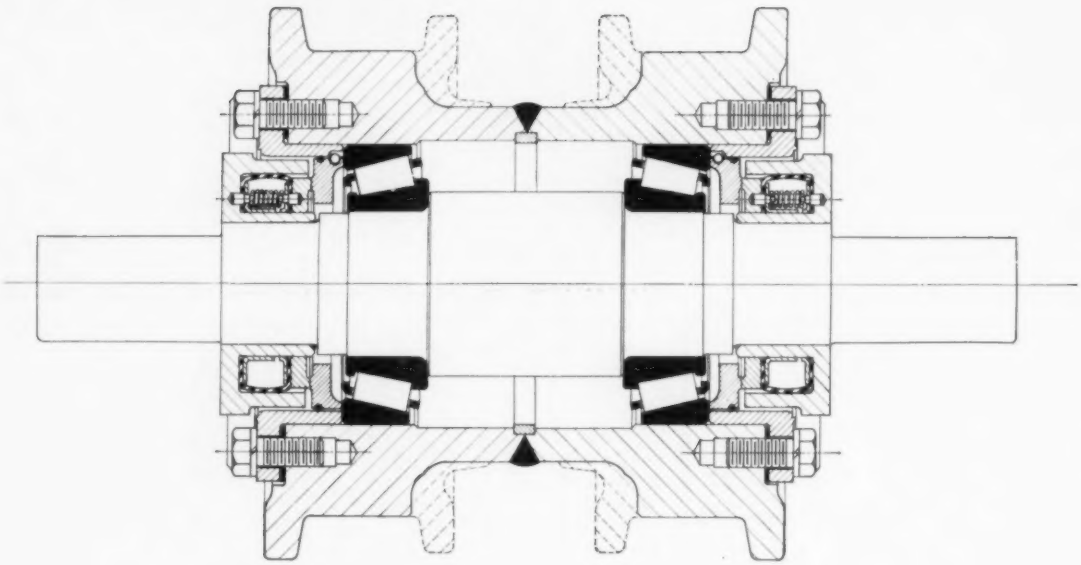
ASCO Valves

ASCO

DEPENDABLE CONTROL BY Automatic Switch Co. 54 HANOVER RD., FLORHAM PARK, N. J. • FRONTIER 7-4600 • *AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL*

CIRCLE 202 ON READER SERVICE CARD

How Allis-Chalmers reduces maintenance, boosts work capacity of their crawler tractors

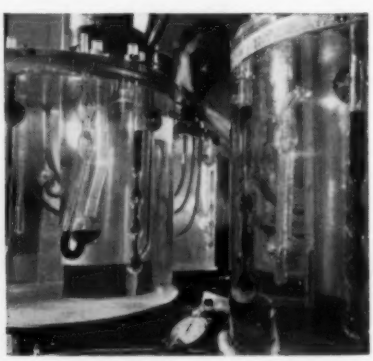


To design *both* greater work capacity and reduced maintenance into their crawler tractors, Allis-Chalmers engineers used Timken® tapered roller bearings for the heavy duty track rollers.

Timken bearings work with the steel sealing rings to effect a positive seal that makes one-time lubrication possible. Timken bearings keep all parts precisely aligned. They protect the seal by minimizing side thrust and wobble, eliminate wear that makes bushing-type assemblies impossible to seal positively. And the tapered design lets Timken bearings take *both* radial and thrust loads. Full-line contact between rollers and races provides extra load-carrying capacity—extra work capacity.

And to deliver more power where it's needed, Timken bearings are also used in the bevel and clutch shaft, final drive pinion, intermediate and sprocket shafts, track idlers and support wheels.

ENGINEERING ASSISTANCE, early in the design stage, helps manufacturers stretch bearing dollars. Timken bearing engineers have the training to do the job and are eager to help you.



METALLURGICAL LAB develops the steels that will make tomorrow's Timken bearings last even longer, help customers to design more economical and durable bearing applications.

Industry rolls on

TIMKEN®

tapered roller bearings

The Timken Roller Bearing Company, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Canadian Division: Canadian Timken, St. Thomas, Ont.

CIRCLE 203 ON READER SERVICE CARD